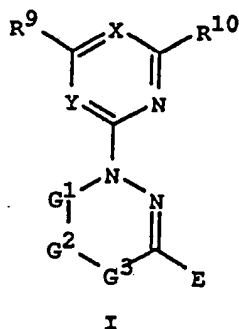


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(54) Title: FUNGICIDAL 1,3,4-OXADIAZINES AND 1,3,4-THIADIAZINES

(I)

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(57) Abstract

Fungicidal 1,3,4-oxadiazines and 1,3,4-thiadiazines of general formula (I) are disclosed, wherein G¹ is -CR¹R²-, -(CHR¹CHR²)-, -(CHR¹CHR²CHR³)-, or -(CHR¹CHR²CHR³CHR⁴)-, G² is -O-, -S-, -S(O)-, -S(O)₂-, or -NR²⁷-, G³ is -CR⁴R⁸-, -(CHR⁵CHR⁶)-, or -(CHR³CHR⁵CHR⁶)- or a direct bond; X is N or CR¹³; Y is N or CR¹³; and E, R⁹, and R¹⁰ are various groups.

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TITLE

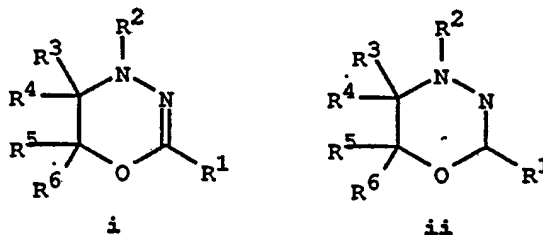
FUNGICIDAL 1,3,4-OXADIAZINES AND 1,3,4-THIADIAZINES

This invention relates to heterocyclic thiadiazines
5 and related heterocycles useful as agricultural
fungicides and compositions containing them.

BACKGROUND OF THE INVENTION

U.S.S.R. patent 461,929 generically discloses
oxadiazines of Formula i and ii

10



wherein:

R¹, R³, R⁴, R⁵, and R⁶ are hydrogen, alkyls,
15 carboxyalkyls, aminoalkyls, phenyl, substituted
phenyls, pyridyls, quinolyls, furyls, or
thienyls, and

R² is alkyl, substituted alkyl, phenyl, substituted
phenyl, or heteroaryl.

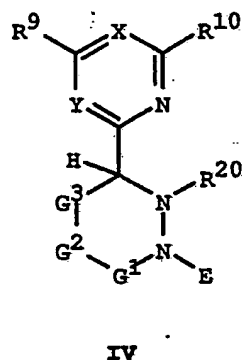
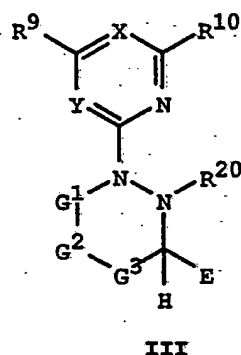
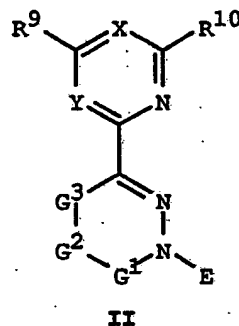
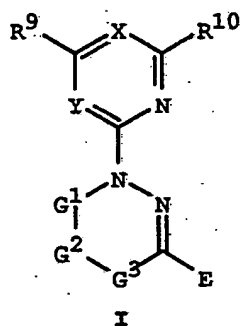
20 U.S.S.R. 461,929 does not specifically name any of
the compounds of the instant invention, nor is any
utility for the compounds disclosed, in this patent.

SUMMARY OF THE INVENTION

This invention pertains to compounds of Formulae I,
25 II, III and IV including all geometric and stereo-
isomers, agriculturally-suitable salts thereof,
agriculturally-suitable metal complexes thereof,
compositions containing them and their use as
fungicides.

30

2



5 wherein:

-G¹-G²-G³- taken together with the attached atoms
form a 5-8 membered ring, wherein

-G¹- is -CR¹R⁷-; -(CHR¹CHR²)-; -(CHR¹CHR²CHR³)-; or
-(CHR¹CHR²CHR³CHR⁴)-;

10 -G²- is -O-; -S-; -S(O)-; -S(O)₂- or -NR²⁷-;

-G³- is -CR⁴R⁸-; -(CHR⁵CHR⁶)-; -(CHR³CHR⁵CHR⁶)- or a
direct bond;

For example, -G¹-G²-G³- can be

-CHR¹CHR²-S-CR⁴R⁸-, wherein -G¹- is

15 -(CHR¹CHR²)-, -G²- is -S-, and -G³- is -CR⁴R⁸-.

The directionality of the -G¹-G²-G³- linkage is

defined as -G¹-G²-G³- in compounds of Formulae

I and III and -G³-G²-G¹- in compounds of

Formulae II and IV. Therefore, for example,

20 when -G¹- is -(CHR¹CHR²)- in a compound of

Formula I or III, then the carbon of the CHR²

unit of -G¹- is bonded to -G²-. In a compound

of Formula II or IV, when $-G^1-$ is $-(CHR^1CHR^2)$,
the carbon of the CHR^1 unit is bonded to $-G^2-$.

X is N or CR^{13} ;

Y is N or CR^{14} ;

5 E is H; C_1-C_6 alkyl; C_3-C_7 cycloalkyl optionally
substituted with 1-2 methyl; C_1-C_6 haloalkyl;
 C_1-C_6 alkylthio; C_1-C_6 alkoxy; C_1-C_6 haloalkoxy;
or phenyl, phenoxy, phenylthio, phenylamino,
phenylmethyl, indanyl, tetrahydronaphthalenyl,
10 1-naphthalenyl, 2-naphthalenyl, thienyl,
furanyl or pyridyl each optionally substituted
with R^{11} , R^{12} and R^{28} ;

R^1 , R^2 , R^3 , R^4 , R^5 , R^6 , R^7 and R^8 are each
independently H; C_1-C_4 alkyl; C_1-C_4 haloalkyl,
15 halogen, CO_2CH_3 , $CO_2CH_2CH_3$, cyano or phenyl
optionally substituted with R^{25} ;

provided that

(i) when $-G^1- = -CR^1R^7-$ and $-G^3- = -CR^4R^8-$,
then at least one of R^1 , R^4 , R^7 and R^8 is
20 hydrogen; in other words the maximum
number of carbon atoms in $-G^1-G^2-G^3-$ with
geminal disubstitution is one;

(ii) the maximum number of optionally
substituted phenyl substituents on
25 $-G^1-G^2-G^3-$ is one;

(iii) $-G^3-$ is other than a direct bond in
compounds of Formulae III and IV; and

(iv) $-G^2-G^3-$ is other than $-NR^{27}-$ in compounds
of Formulae I and II;

30 R^9 , R^{10} and R^{13} are each independently H; halogen;
cyano; hydroxy; C_1-C_6 alkyl; C_1-C_4 haloalkyl;
 C_1-C_4 alkylthio; C_1-C_4 alkylsulfinyl; C_1-C_4
alkylsulfonyl; C_3-C_6 cycloalkyl optionally
substituted with 1-2 methyl groups; C_1-C_4
35 alkoxy; C_1-C_4 haloalkoxy; C_2-C_4 alkoxyalkyl;
 C_2-C_4 alkenyl; C_2-C_4 haloalkenyl; C_2-C_4

- alkenyloxy; C₂-C₄ alkynyl; C₂-C₄ alkynyloxy;
NR²⁹R³⁰; or phenyl or phenoxy optionally
substituted with R³¹; or
- 5 R⁹ and R¹³, or R¹⁰ and R¹³, or R⁹ and R¹⁴ can be
taken together to form -(CH₂)₃-, -(CH₂)₄- or a
fused benzene ring optionally substituted with
R³¹;
- R¹¹, R¹², R²¹, R²⁴, R²⁶ and R³¹ are each
independently halogen; C₁-C₄ alkyl; C₁-C₄
10 haloalkyl; C₁-C₄ alkoxy; or C₁-C₄ haloalkoxy;
R¹⁴ is H; halogen; C₁-C₂ alkyl; or C₁-C₂ alkoxy;
R¹⁵, R¹⁶, R¹⁷, R¹⁸, R²⁹ and R³⁰ are each
independently H or C₁-C₂ alkyl; or
R¹⁵ and R¹⁶, or R¹⁷ and R¹⁸, or R²⁹ and R³⁰ can be
15 taken together along with the nitrogen atom to
which they are attached to form a
4-morpholinyl, pyrrolidinyl or piperidinyl
ring;
- R²⁰ and R²⁷ are each independently H; C₁-C₄ alkyl;
20 C₁-C₄ haloalkyl; C₂-C₅ alkylcarbonyl; phenyl-
carbonyl optionally substituted with R²¹; C₃-C₄
alkenyl; C₃-C₄ alkynyl; phenylmethyl optionally
substituted with R²¹ on the phenyl ring; C₁-C₄
alkylsulfinyl; C₁-C₄ alkylsulfonyl; phenyl-
25 sulfinyl, phenylsulfonyl or phenoxycarbonyl
each optionally substituted with R²¹; C₂-C₄
alkoxycarbonyl; C(=O)NR²²R²³; C(=S)NHR²³;
P(=S)(C₁-C₄ alkoxy)₂; P(=O)(C₁-C₄ alkoxy)₂; or
S(=O)₂NR²²R²³;
- 30 R²² is H or C₁-C₃ alkyl;
R²³ is C₁-C₄ alkyl; or phenyl optionally
substituted with R²⁴; or
R²² and R²³ can be taken together along with the
nitrogen atom to which they are attached to
35 form a 4-morpholinyl, pyrrolidinyl, piperidinyl
or imidazolyl ring;

R²⁵ is 1-2 halogen; C₁-C₄ alkyl; C₁-C₄ haloalkyl; C₁-C₄ alkoxy; C₁-C₄ haloalkoxy; nitro; cyano or C₁-C₄ alkylthio;

R²⁸ is halogen; cyano; nitro; hydroxy; hydroxycarbonyl; C₁-C₆ alkyl; C₃-C₆ cycloalkyl; C₁-C₆ haloalkyl; C₁-C₄ alkylthio; C₁-C₄ alkylsulfinyl; C₁-C₄ alkylsulfonyl; (C₁-C₄ alkyl)3-silyl; C₂-C₅ alkylcarbonyl; C₂-C₄ alkenyl; C₃-C₄ alkenyloxy; C₂-C₄ alkynyl; C₃-C₄ alkynyloxy; C₁-C₄ alkoxy; C₁-C₄ haloalkoxy; C₂-C₄ alkoxy-alkyl; C₂-C₅ alkoxy-carbonyl; C₂-C₄ alkoxy-alkoxy; NR¹⁵R¹⁶; C(=O)NR¹⁷R¹⁸; or phenyl, phenoxy or phenylthio each optionally substituted with R²⁶;

provided that

when E is, C₁-C₆ alkylthio, C₁-C₆ alkoxy, C₁-C₆ haloalkoxy, phenoxy, phenylthio or phenylamino, then E may only substitute compounds of Formula I.

In the above recitations, the term "alkyl", used either alone or in compound words such as "alkylthio" or "haloalkyl" denotes straight-chain or branched alkyl; e.g., methyl, ethyl, *n*-propyl, *i*-propyl, or the different butyl, pentyl or hexyl isomers.

"Alkenyl" denotes straight-chain or branched alkenes; e.g., 1-propenyl, 2-propenyl, 3-propenyl and the different butenyl, pentenyl and hexenyl isomers. "Alkenyl" also denotes polyenes such as 1,3-hexadiene and 2,4,6-heptatriene.

"Alkenyloxy" denotes straight-chain or branched alkenyloxy moieties. Examples of alkenyloxy include H₂C=CHCH₂O, (CH₃)₂C=CHCH₂O, (CH₃)CH=CHCH₂O, (CH₃)CH=C(CH₃)CH₂O and CH₂=CHCH₂CH₂O.

"Alkynyl" denotes straight-chain or branched alkynes; e.g., ethynyl, 1-propynyl, 3-propynyl and the different butynyl, pentynyl and hexynyl isomers.

"Alkynyl" can also denote moieties comprised of multiple triple bonds; e.g., 2,7-octadiyne and 2,5,8-decatriyne.

"Alkynyloxy" denotes straight-chain or branched alkynyloxy moieties. Examples include $\text{HC}\equiv\text{CCH}_2\text{O}$, $\text{CH}_3\text{C}\equiv\text{CCH}_2\text{O}$ and $\text{CH}_3\text{C}\equiv\text{CCH}_2\text{CH}_2\text{O}$.

"Alkylthio" denotes branched or straight-chain alkylthio moieties; e.g. methylthio, ethylthio, and the different propylthio, butylthio, pentylthio and hexylthio isomers.

Examples of "alkylsulfonyl" include CH_3SO_2 , $\text{CH}_3\text{CH}_2\text{SO}_2$, $\text{CH}_3\text{CH}_2\text{CH}_2\text{SO}_2$, $(\text{CH}_3)_2\text{CHSO}_2$ and the different butylsulfonyl, pentylsulfonyl and hexylsulfonyl isomers.

"Alkylsulfinyl" denotes both enantiomers of an alkylsulfinyl group. For example, CH_3SO , $\text{CH}_3\text{CH}_2\text{SO}$, $\text{CH}_3\text{CH}_2\text{CH}_2\text{SO}$, $(\text{CH}_3)_2\text{CHSO}$ and the different butylsulfinyl, pentylsulfinyl and hexylsulfinyl isomers.

"Alkoxy" denotes, for example, methoxy, ethoxy, *n*-propyloxy, isopropyloxy and the different butoxy, pentoxy and hexyloxy isomers.

"Cycloalkyl" denotes, for example, cyclopropyl, cyclobutyl, cyclopentyl, and cyclohexyl.

The term "halogen", either alone or in compound words such as "haloalkyl", denotes fluorine, chlorine, bromine or iodine. Further, when used in compound words such as "haloalkyl", said alkyl may be partially or fully substituted with halogen atoms which may be the same or different. Examples of "haloalkyl" include F_3C , ClCH_2 , CF_3CH_2 and CF_3CF_2 . Examples of "haloalkenyl" include $(\text{Cl})_2\text{C}=\text{CHCH}_2$ and $\text{CF}_3\text{CH}_2\text{CH}=\text{CHCH}_2$. Examples of "haloalkynyl" include $\text{HC}\equiv\text{CCHCl}$, $\text{CF}_3\text{C}\equiv\text{C}$, $\text{CCl}_3\text{C}\equiv\text{C}$ and $\text{FCH}_2\text{C}\equiv\text{CCH}_2$. Examples of "haloalkoxy" include CF_3O , $\text{CCl}_3\text{CH}_2\text{O}$, $\text{CF}_2\text{HCH}_2\text{CH}_2\text{O}$ and $\text{CF}_3\text{CH}_2\text{O}$.

The total number of carbon atoms in a substituent group is indicated by the " $\text{C}_i\text{-C}_j$ " prefix where *i* and *j*

are numbers from 1 to 8. For example, C₁-C₃ alkyl-sulfonyl designates methylsulfonyl through propyl-sulfonyl; C₂ alkoxyalkoxy designates CH₃OCH₂O; C₃ alkoxyalkoxy designates, for example, CH₃OCH₂CH₂O or
5 CH₃CH₂OCH₂O; and C₄ alkoxyalkoxy designates the various isomers of an alkoxy group substituted with a second alkoxy group containing a total of 4 carbon atoms, examples including CH₃CH₂CH₂OCH₂O, and CH₃CH₂OCH₂CH₂O. Examples of "alkoxyalkyl" include CH₃OCH₂, CH₃OCH₂CH₂,
10 CH₃CH₂OCH₂, CH₃CH₂CH₂CH₂OCH₂ and CH₃CH₂OCH₂CH₂. Examples of "alkoxycarbonyl" include CH₃OC(=O), CH₃CH₂OC(=O), CH₃CH₂CH₂OC(=O), (CH₃)₂CHOC(=O) and the different butoxy-, pentoxy- or hexyloxycarbonyl isomers.

Preferred for reasons of greatest fungicidal
15 activity and/or ease of synthesis are

1. Compounds of Formula I wherein:

Y is N;

E is phenyl, indanyl, tetrahydronaphthalenyl,
1-naphthalenyl, thienyl, or pyridyl each
20 optionally substituted with R¹¹, R¹² and R²⁸;

R¹, R², R³, R⁴, R⁵, R⁶, R⁷ and R⁸ are each independently H or methyl;

R¹¹ and R¹² are each independently F, Cl,
25 methyl, trifluoromethyl, methoxy or trifluoromethoxy;

R¹³ is H;

R⁹ and R¹⁰ are each independently halogen;
C₁-C₄ alkyl; cyclopropyl; C₁-C₄ haloalkyl;
30 allyl; or C₂-C₃ alkynyl; or

R⁹ and R¹³ can be taken together to form a fused benzene ring optionally substituted with R³¹;

R²⁸ is halogen; cyano; C₁-C₄ alkyl; C₁-C₄ haloalkyl; allyl; propargyl; C₁-C₄ alkoxy; C₁-C₄ haloalkoxy; or phenyl or
35

phenoxy each optionally substituted with
R²⁶;

R³¹ is halogen; C₁-C₄ alkyl or C₁-C₄ halo-
alkyl;

5 and agriculturally-suitable metal complexes
thereof.

2. Compounds of Formula III wherein:

Y is N

10 E is phenyl, indanyl, tetrahydronaphthalenyl,
1-naphthalenyl, thienyl, or pyridyl each
optionally substituted with R¹¹, R¹² and
R²⁸;

R¹, R², R³, R⁴, R⁵, R⁶, R⁷ and R⁸ are each
independently H or methyl;

15 R⁹ and R¹⁰ are each independently halogen;
C₁-C₄ alkyl; cyclopropyl; C₁-C₄ haloalkyl;
allyl; or C₂-C₃ alkynyl; or

R⁹ and R¹³ can be taken together to form a
fused benzene ring optionally substituted
20 with R³¹;

R¹¹ and R¹² are each independently F, Cl,
methyl, trifluoromethyl, methoxy or
trifluoromethoxy;

R¹³ is H;

25 R²⁰ is H;

R²⁷ is H; C₁-C₄ alkyl; C₂-C₅ alkoxy carbonyl;
C₃-C₄ alkenyl or C₃-C₄ alkynyl;

30 R²⁸ is halogen; cyano; C₁-C₄ alkyl; C₁-C₄
haloalkyl; allyl; propargyl; C₁-C₄
alkoxy; C₁-C₄ haloalkoxy; or phenyl or
phenoxy each optionally substituted with
R²⁶;

R³¹ is halogen; C₁-C₄ alkyl or C₁-C₄ halo-
alkyl;

35 and agriculturally-suitable metal complexes
thereof.

3. Compounds of Preferred 1 wherein:

G² is O; S or NR²⁷;

E is phenyl optionally substituted with R¹¹,
R¹² and R²⁸; indanyl or tetrahydro-
naphthalenyl; and agriculturally-suitable
metal complexes thereof.

4. Compounds of Preferred 3 wherein:

G² is O; S; NH or N(C₁-C₄ alkyl);

E is phenyl optionally substituted with R¹¹,
R¹² and R²⁸; and agriculturally-suitable
metal complexes thereof.

Specifically preferred for greatest fungicidal
activity and/or ease of synthesis are:

3-(4,6-dimethyl-2-pyrimidinyl)-3,6-dihydro-5-
phenyl-2H-1,3,4-oxadiazine

3-(4,6-dimethyl-2-pyrimidinyl)-5-(4-ethylphenyl)-
3,6-dihydro-2H-1,3,4-oxadiazine

2-(2-chlorophenyl)-4-(4,6-dimethyl-2-
pyrimidinyl)-5,6-dihydro-4H-1,3,4-thiadiazine

4-(4,6-dimethyl-2-pyrimidinyl)-2-(4-ethylphenyl)-
5,6-dihydro-4H-1,3,4-thiadiazine

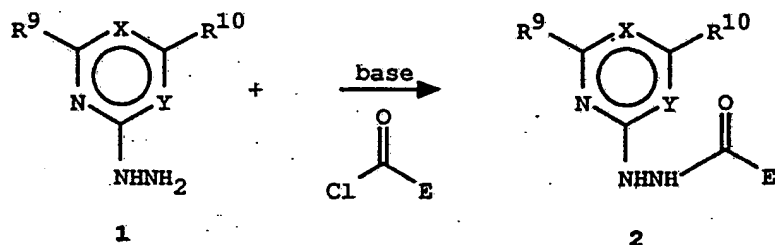
DETAILED DESCRIPTION OF THE INVENTION

Compounds of Formula I wherein E is as described in
the Summary of the Invention except that E is not
phenoxy, phenylthio, phenylamino, C₁-C₆ alkoxy, C₁-C₆
alkylthio and C₁-C₆ haloalkoxy can be prepared by one
or more of the methods described in Equations 1-6 and
13.

Compounds of Formula 2 in Equation 1 can be
prepared by reacting hydrazine 1 with an acid chloride
and a base such as pyridine or triethylamine at 0°C in
a solvent such as dichloromethane, THF, or pyridine
(Equation 1). The hydrazines 1 are known in the

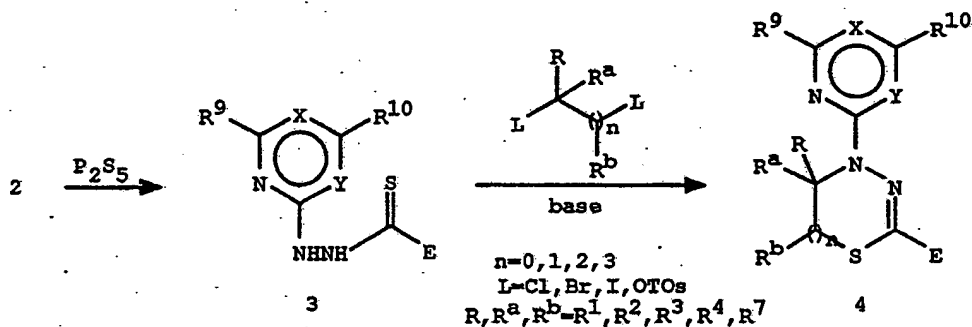
literature (*J. Pest. Sci.*, 1990, 15, 13) and can be prepared by one skilled in the art as taught in EP 293,743-A and by Naito et al. in *Chem. Pharm. Bull.*, 1969, 17, 1467.

5 Equation 1



Compounds of Formula 4 can be prepared by treatment of hydrazides of Formula 2 with P_2S_5 in pyridine at reflux for 1-2 h to form thiohydrazides of Formula 3, followed by reaction with an appropriate alkylating agent, wherein L can be Cl, Br, I or tosylate, in the presence of two equivalents of base, such as triethylamine (Equation 2). In some cases, additional base such as sodium hydride is necessary to induce cyclization. The cyclization reaction is typically performed at 25° to 100°C in an inert aprotic solvent such as THF or acetonitrile.

20 Equation 2

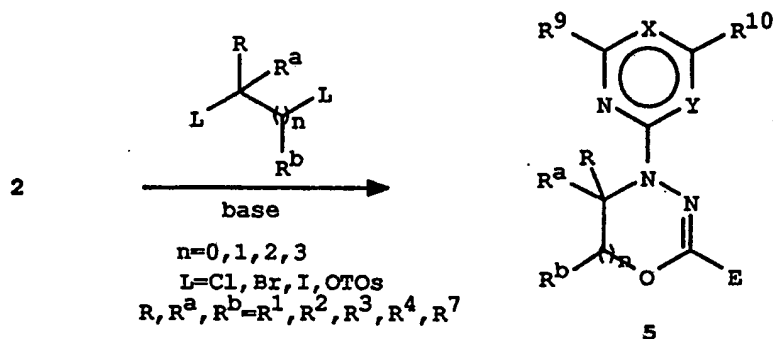


Compounds of Formula 5 can be prepared similarly by treatment of hydrazides of Formula 2 with an alkylating

agent and two equivalents of base using the cyclization procedure previously described for the preparation of compounds of Formula 4 (Equation 3).

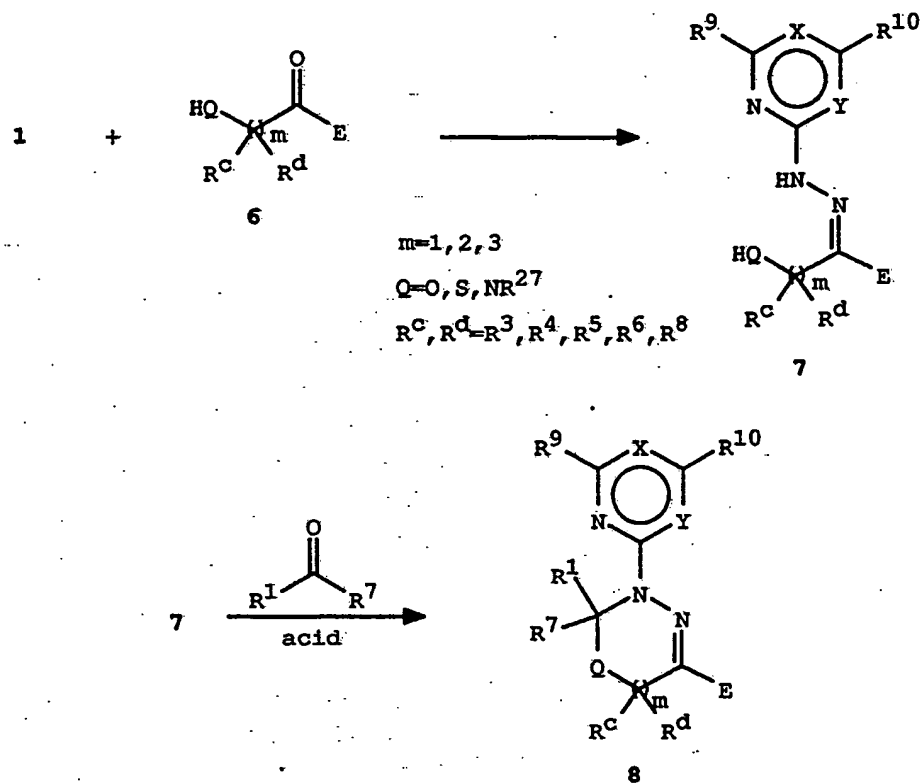
Equation 3

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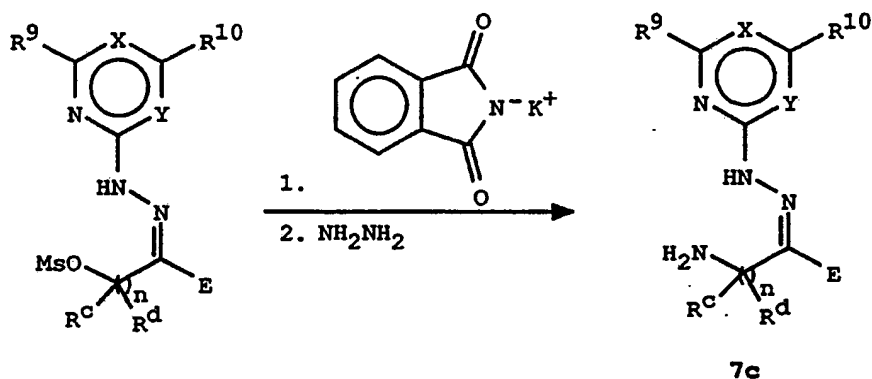
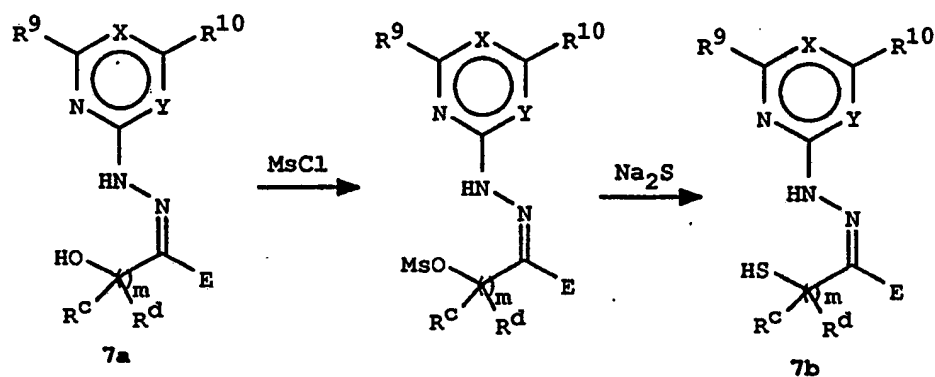
Compounds of Formula 7 can be prepared by the reaction of hydrazines of Formula 1 with ketones of Formula 6 in a solvent such as acetonitrile, dichloromethane or acetic acid. The desired heterocycles of Formula 8 can be formed by treatment of the resulting product with a ketone or aldehyde in the presence of a catalytic amount of acid such as butanesulfonic acid (Equation 4). This reaction is typically conducted at 25° to 100°C in an anhydrous organic solvent such as THF or acetonitrile for 12 to 24 h.

Equation 4



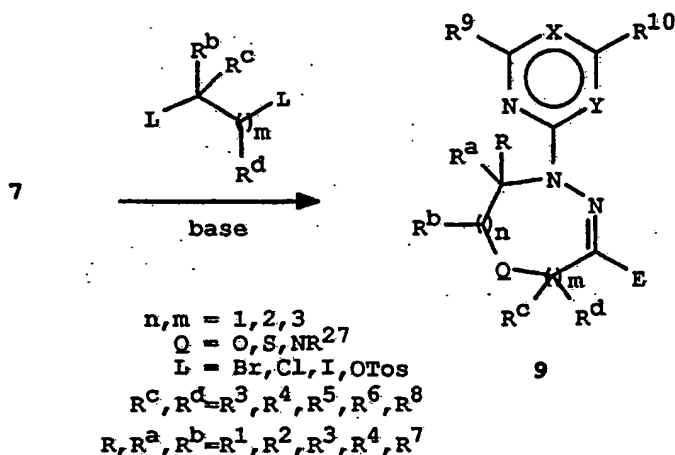
Compounds of Formula 6 wherein m=1 and Q=0 can be prepared by α -hydroxylation of a methyl ketone with iodosobenzene as described by Moriarty et al. in *Tetrahedron Lett.*, 1981, 22, 1283.

Thiols of Formula 7b and amines of Formula 7c can be prepared as outlined in Equation 5. Alcohols of Formula 7a (Q=O) can be converted to the corresponding mesylate by methods known in the art. The mesylates can be treated with sodium sulfide to form the thiols 7b, or they can be reacted with potassium phthalimide and then hydrazine to form amines of Formula 7c.

Equation 5

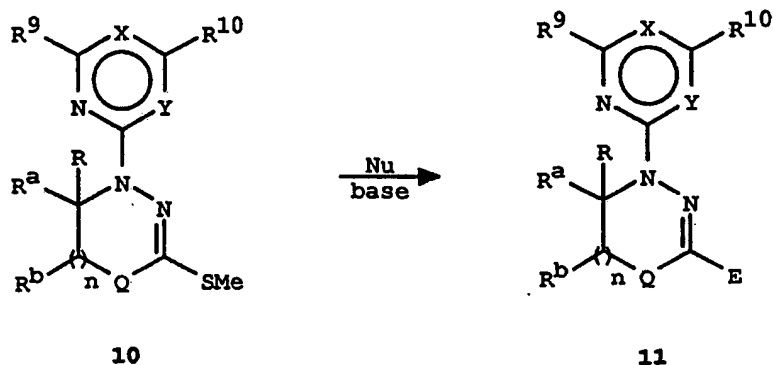
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Formation of heterocycles of Formula 9 can be accomplished by treatment of hydrazones of Formula 7 with the appropriate alkylating agent as previously described for the preparation of heterocycles of Formula 4 (Equation 6).

Equation 6

- 5 Compounds of Formula I wherein E is phenoxy, phenylthio, phenylamino, C₁-C₆ alkoxy, C₁-C₆ alkylthio or C₁-C₆ haloalkoxy can be prepared by one or more of the methods described in Equations 7-13.

- 10 Heterocycles of Formula 11 can be prepared by treating methylthio-substituted compounds of Formula 10 with various nucleophiles in the presence of a base. Suitable nucleophiles can be optionally substituted phenols, thiophenols, or anilines, C₁-C₆ alkylthiols, C₁-C₆ alcohols and C₁-C₆ halo-substituted alcohols
- 15 (Equation 7).

Equation 7

Nu = optionally substituted phenol, thiophenol, or
 5 aniline; C₁-C₆ alkylthiol; C₁-C₆ alcohol,
 C₁-C₆ halo-substituted alcohol

n = 0, 1, 2, 3

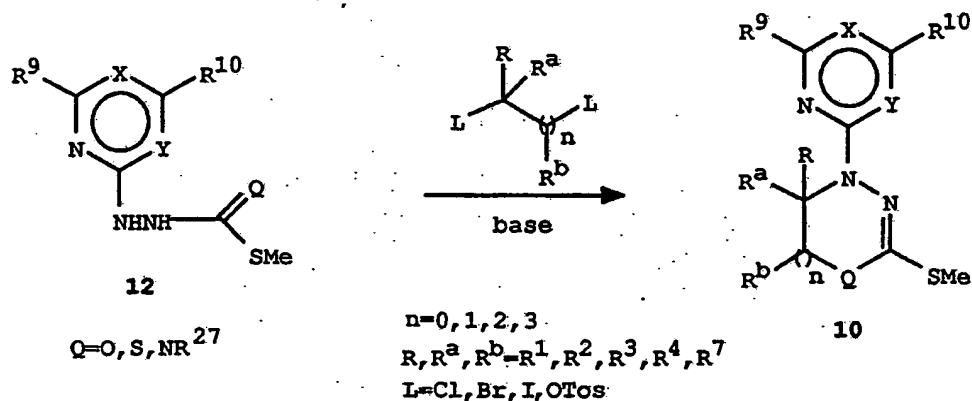
Q = O, S, N-R²⁷

R, R^a, R^b = R¹, R², R³, R⁴, R⁷

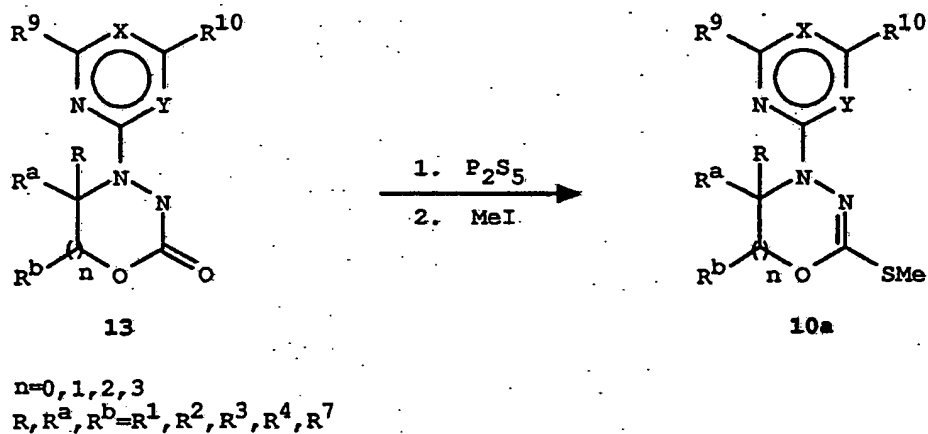
10

The methythio-substituted heterocycles of Formula
 10 can be synthesized by reaction of carbazates of
 Formula 12 with an alkylating agent in the presence of
 two equivalents of base, such as triethylamine
 15 (Equation 8). This type of cyclization was described
 previously for the preparation of compounds of Formula
 4 (Equation 2). Compounds of Formula 12 are known in
 the literature and can be prepared by one skilled in
 the art (e.g., see G. W. Stacy, "Heterocyclic
 20 Compounds," R. C. Elderfield, ed., Wiley, NY, 1961,
 vol. 7, p 835).

16

Equation 8

- 5 Alternatively, compounds of Formula 10a can be prepared by sequential treatment of carbazates of Formula 13 with P_2S_5 and iodomethane in pyridine (Equation 9). Carbazates of Formula 13 are known in the literature (e.g., see Dox, *J. Am. Chem. Soc.*, 1926, 48, 1951).

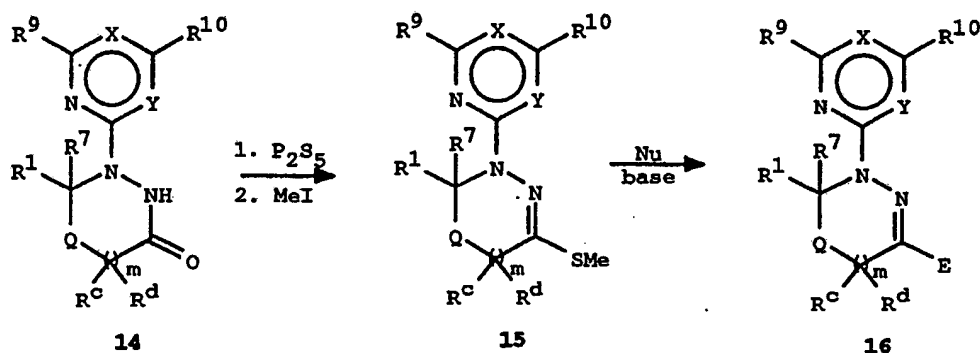
Equation 9

- 15 Methylthio-substituted heterocycles of Formula 15 can be prepared by treating hydrazides of Formula 14 with P_2S_5 in pyridine at reflux and then alkylating the resulting thio derivative with iodomethane in the presence of a base such as triethylamine (Equation 10).

Reaction of compounds of Formula 15 with nucleophiles and base, as previously described for the preparation of compounds of Formula 11 in Equation 7, yields products of Formula 16. The seven-membered ring

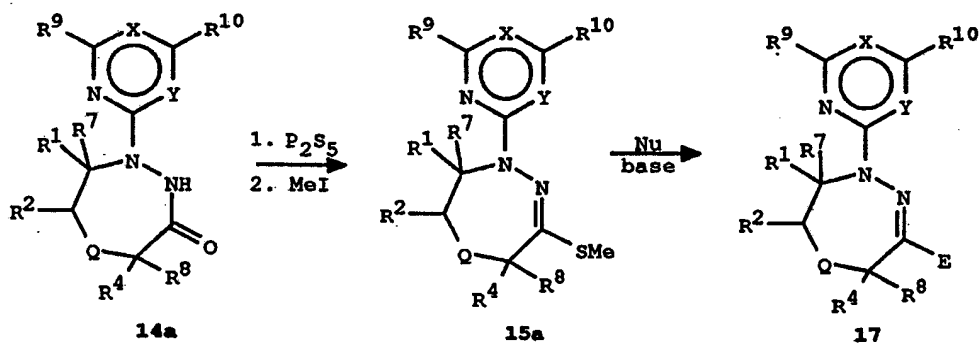
- 5 analogs, compounds of Formula 17, can be prepared from hydrazides of Formula 14a by the same procedure (Equation 10).

Equation 10



10

$m = 1, 2, 3; Q = O, S, N-R^{27}; R^c, R^d = R^3, R^4, R^5, R^6, R^8$

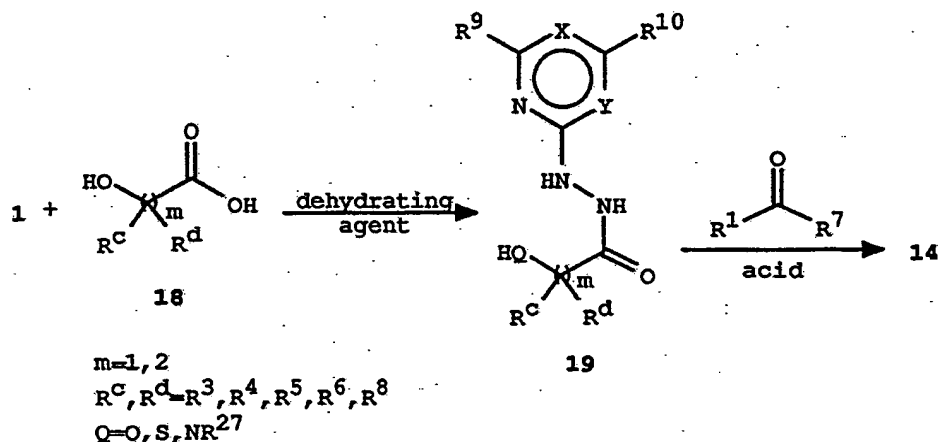


$Q=O, S, NR^{27}$

- 15 Treatment of hydrazides of Formula 19 with an aldehyde or ketone in the presence of a catalytic amount of acid, such as butanesulfonic acid, yields heterocycles of Formula 14 (Equation 11). The cyclization is typically performed at 25° to 100°C in

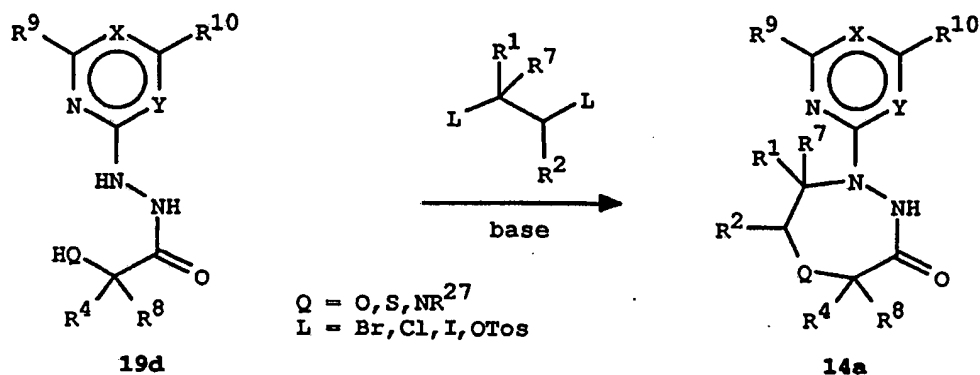
an anhydrous organic solvent such as THF or acetonitrile.

Equation 11

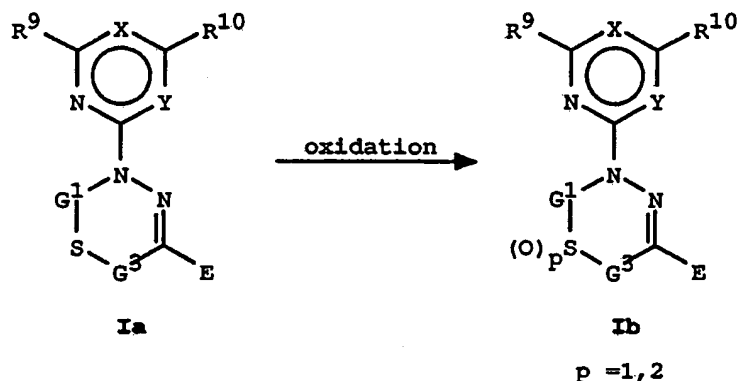


Compounds of Formula 19a (Q=O) can be synthesized by condensing hydrazine 1 with hydroxyacids of Formula 18 in the presence of a dehydrating agent such as dicyclohexylcarbodiimide in an inert aprotic solvent such as THF or dichloromethane. Hydroxyacids of Formula 18 are well-known to one skilled in the art. Thiols of Formula 19b (Q=S) and amines of Formula 19c (Q=NR²⁷) can be prepared by forming the mesylate of alcohols of Formula 19a followed by displacement with nucleophiles in a manner similar to that previously described for the preparation of compounds of Formulae 7b and 7c (Equation 5).

Compounds of 14a can be prepared by treatment of hydrazides of Formula 19d (m=1) with the appropriate alkylating agent, as illustrated in Equation 12, according to procedures described above (see Equations 2 and 3).

Equation 12

- 5 Compounds of Formula **Ib** wherein G^2 is $\text{S}(\text{O})$ or $\text{S}(\text{O})_2$ can be prepared from the corresponding thio analogue **Ia** by well-known methods for oxidation of sulfur (Equation 13). Typical reagents for this type of oxidation include *m*-chloroperoxybenzoic acid, hydrogen peroxide, sodium metaperiodate, and OXONE® (potassium peroxymono-
- 10 sulfate).

Equation 13

15

Compounds of Formula **II** can be prepared by one or more of the following methods described in Equations 14-19.

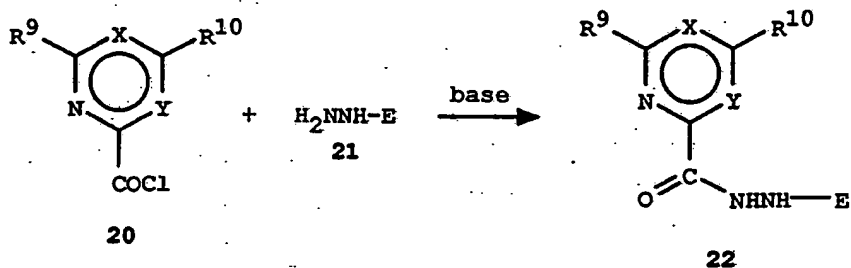
Hydrazides of Formula **22** can be synthesized by the

20 reaction of hydrazine **21** with an acid chloride of

Formula 20 in the presence of a base such as triethylamine or pyridine (Equation 14). Typical solvents for this reaction are dichloromethane and THF.

Equation 14

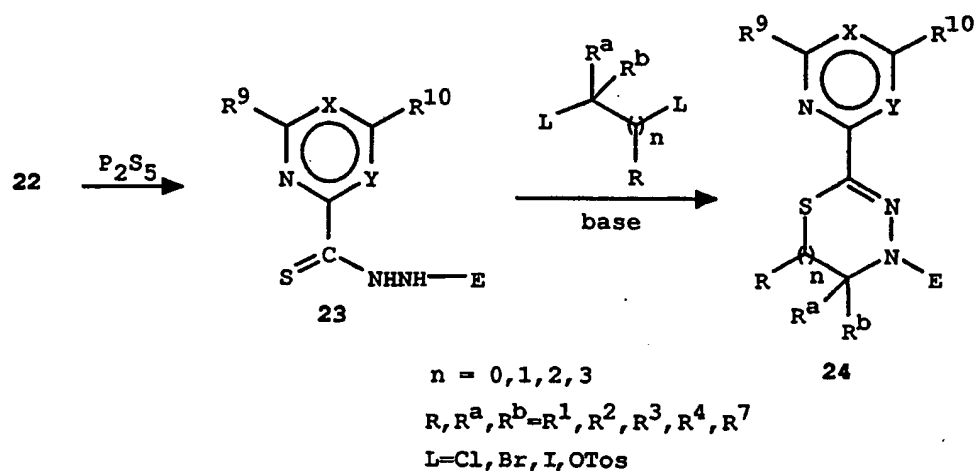
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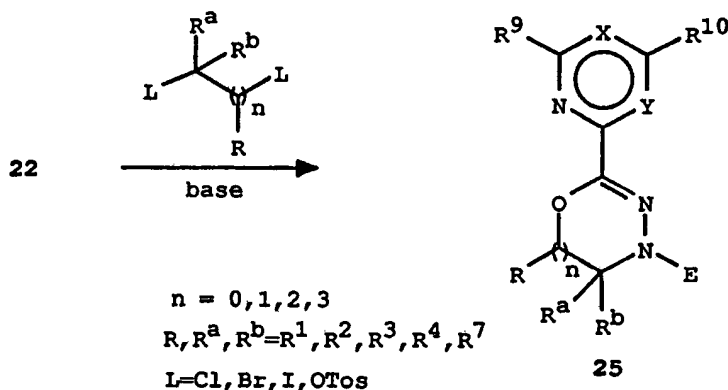
The acid chloride of Formula 20 can be prepared by treatment of the corresponding carboxylic acid with thionyl chloride. Methods for preparing acid chlorides from carboxylic acids are well-known in the literature.

Procedures for preparing pyrimidine carboxylic acids are described by Sakamoto, T., and Yamanaka, H. in *Heterocycles*, 1981, 15, 583.

Heterocycles of Formula 24 can be prepared by treating hydrazides of Formula 22 with P_2S_5 in pyridine at reflux to form the thiohydrazides of Formula 23, followed by reaction of 23 with an alkylating agent in the presence of two equivalents of base such as triethylamine (Equation 15). Typically, these reactions are conducted at 25° to 100°C in an inert aprotic solvent such as THF or acetonitrile.

Equation 15

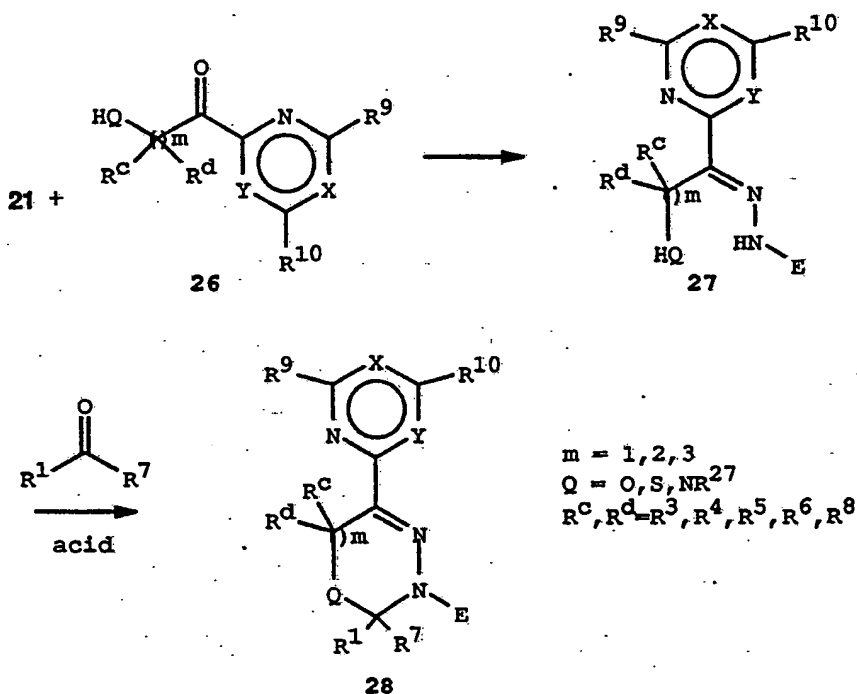
5 Compounds of Formula 25 can be prepared similarly by treatment of hydrazides of Formula 22 with an alkylating agent and two equivalents of base according to the previously described cyclization procedure (Equation 16).

10 Equation 16

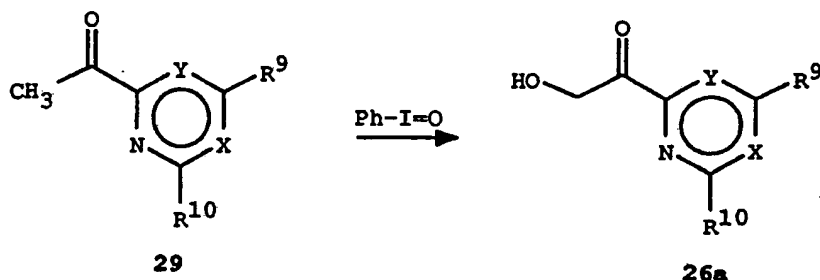
15 Compounds of Formula 28 can be synthesized by the reaction of hydrazines of Formula 21 with ketones of Formula 26 in a solvent such as dichloromethane or acetonitrile to form hydrazones of Formula 27 (Equation 17). The hydrazone can then be treated with a ketone

or aldehyde in the presence of a catalytic amount of acid, such as butanesulfonic acid, to form cycloadducts of Formula 28. This reaction is typically carried out at 25° to 100°C in an anhydrous organic solvent such as THF or acetonitrile.

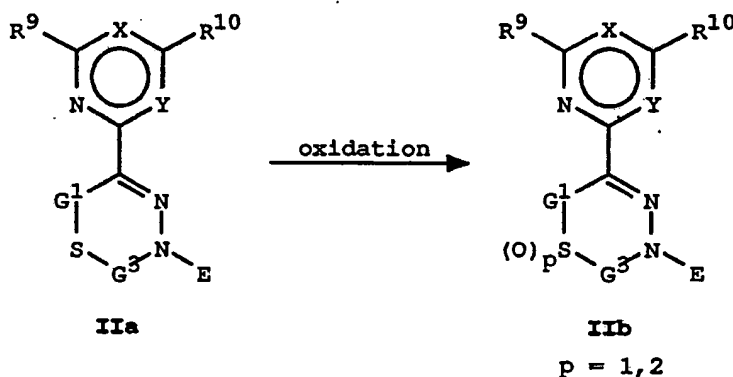
Equation 17



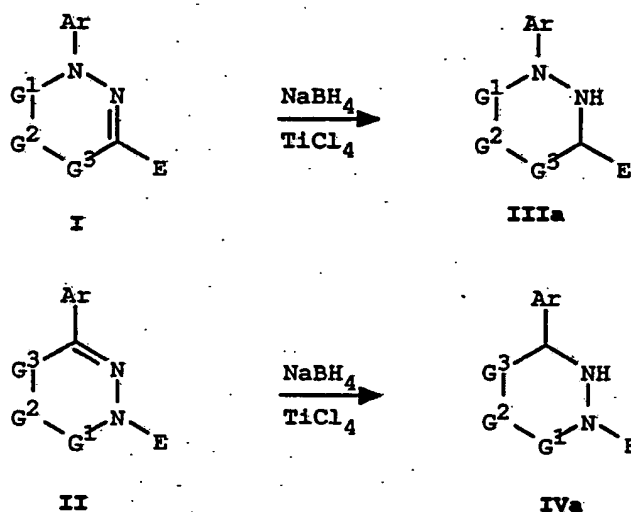
- 10 Hydroxyketones of Formula 26a ($Q=O$, $m=1$) can be prepared by α -hydroxylation of the corresponding methyl ketone 29 with iodosobenzene as described by Moriarty et al. in *Tetrahedron Lett.*, 1981, 22, 1283, and illustrated in Equation 18. Methods to prepare
- 15 heteroaryl ketones of Formula 29 are well-known in the art. The corresponding thiols of Formula 26b ($Q=S$) and amines of Formula 26c ($Q=NR^{27}$) can be prepared by methods previously described for thiols and amines of Formulae 7b and 7c, respectively (Equation 5).

Equation 18

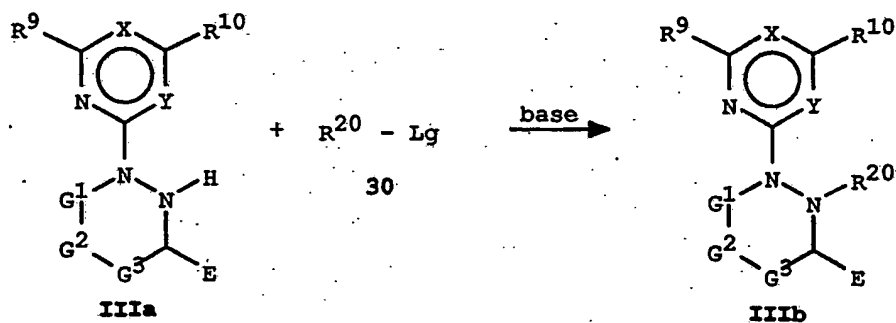
- 5 Compounds of Formula IIb can be synthesized from the corresponding thio analogue of Formula IIa by oxidation (Equation 19). Typical reagents for this type of oxidation include *m*-chloroperoxy benzoic acid, hydrogen peroxide, sodium metaperiodate, and OXONE® (potassium peroxymonosulfate).

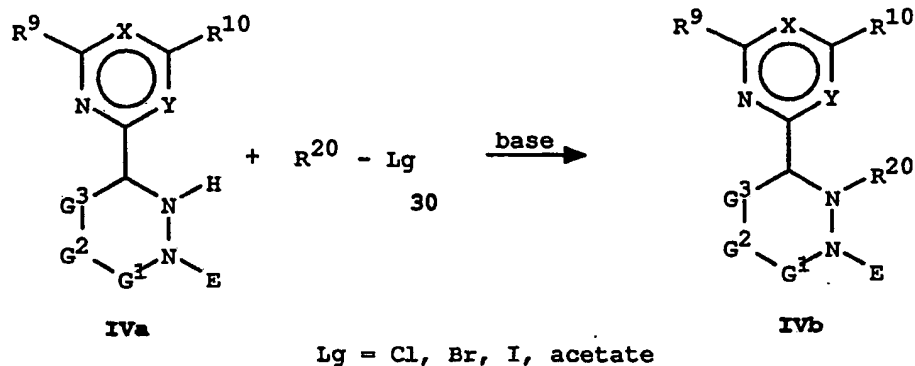
Equation 19

- 15 Compounds of Formulae IIIa and IVa can be prepared by reduction of compounds of Formulae I and II, respectively, with sodium borohydride/titanium (IV) chloride according to the procedure taught by Kano et al. in *Synthesis*, 1980, 695, and set forth in Equation
- 20 20. In cases where substituents in compounds of Formulae I and II are not compatible with the reduction conditions, protection and deprotection techniques, which are well-known in the art may be employed.

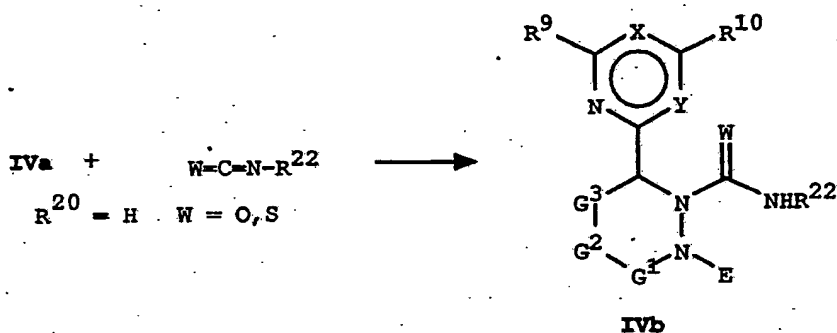
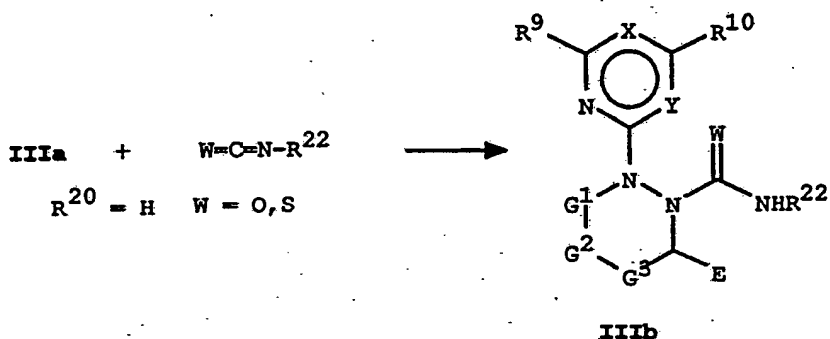
Equation 20

- 5 Compounds of Formulae IIIa and IVa can be capped on nitrogen with various substituents (R^{20}) by treating with the appropriate alkylating, acylating, sulfonylating or phosphonylating agent of Formula 30 as shown in Equation 21. The leaving group (Lg) in
- 10 compounds of Formula 30 may be Cl, Br, I, acetate or other moiety known to act as a leaving group. Typically, these reactions are run in inert solvents such as THF, benzene or dichloromethane in the presence of a tertiary amine base, such as triethylamine, at a
- 15 temperature ranging from 0° to 100°C .

Equation 21

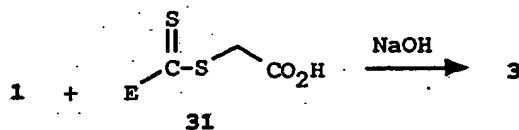


Compounds of Formula **IIIb** and **IVb** wherein R^{20} is
 5 $\text{C}(=\text{O})\text{NR}^{22}\text{R}^{23}$ or $\text{C}(=\text{S})\text{NHR}^{23}$ can be prepared by treating
 compounds of Formulae **IIIa** or **IVa** with an isocyanate or
 isothiocyanate by methods well-known in the art (Equation
 22). Typical solvents for this type of reaction are THF,
 acetonitrile and dichloromethane.

Equation 22

5

Compounds of Formula 3, as illustrated in Equation 2, can also be prepared by reacting hydrazine 1 with the appropriate carboxymethyl dithioate 31 in aqueous sodium hydroxide at 25°C (Equation 23). Carboxymethyl dithioates are known in the literature and can be prepared by one skilled in the art (see Jensen, K. A. and Pedersen, C., *Acta Chemica Scandinavica*, 1961, 15, 1087).

15 Equation 23

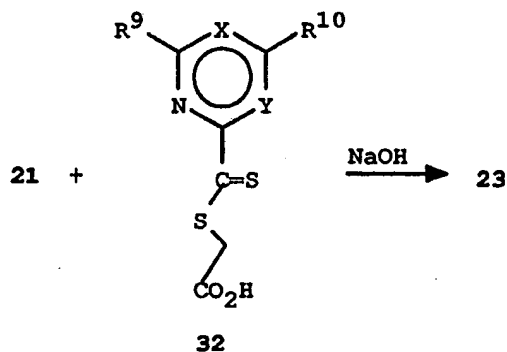
Likewise, thiohydrazides of Formula 23, as illustrated in Equation 15, can be synthesized by

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reaction of a hydrazine of Formula 21 with a carboxymethyl dithioate of Formula 32 in aqueous sodium hydroxide (Equation 24).

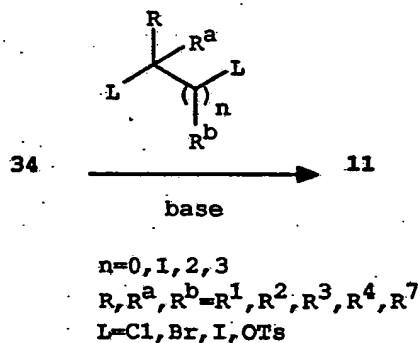
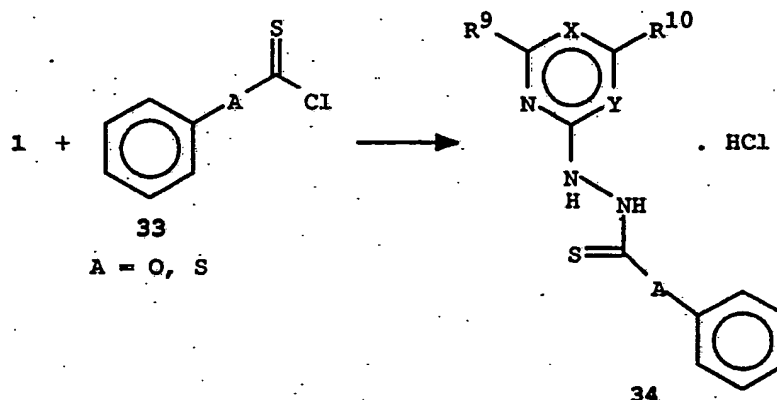
Equation 24

5



Compounds of Formula 11, wherein E is phenoxy or phenylthio, can also be synthesized by treating a hydrazine of Formula 1 with phenyl-chlorothionoformate or phenyl-chlorodithioformate of Formula 33 to form a thiocarbazate hydrochloride of Formula 34 (Equation 25). This type of reaction is typically run in a solvent such as methylene chloride from about -10°C to 0°C. The cyclization is performed by treating 39 with the appropriate alkylating agent in a solvent mixture of aqueous sodium hydroxide and THF at 25°C.

Equation 25



5

The metal complexes of compounds of Formulae I-IV of the instant invention include complexes with copper, zinc, iron, magnesium, or manganese. These complexes can be formed by combining the compound of Formulae I-IV with the metal salt in either aprotic solvents, such as ether or THF, or protic solvents, such as methanol. EP-A-459,662 discloses metal complexes of other nitrogen containing compounds as agricultural fungicides.

EXAMPLE 1

Preparation of 1-(4-ethylphenyl)-2-hydroxyethanone(4,6-dimethyl-2-pyrimidinyl)hydrazone

To a solution of 3.57 g (21.7 mmol) of *p*-ethyl-2-hydroxyacetophenone in 100 mL of acetonitrile was added 3.00 g (21.7 mmol) of 4,6-dimethyl-2-hydrazinopyrimi-

dine, 3Å molecular sieves, and a catalytic amount of butanesulfonic acid. The reaction mixture was stirred overnight at room temperature and then diluted with dichloromethane and chloroform. The organic phase was washed successively with saturated sodium bicarbonate and brine, dried over sodium sulfate, filtered and concentrated. The crude product was passed through a plug of silica gel and triturated with hexanes to yield 3.45 g of product. ¹H NMR (CDCl₃) δ 10.65 (bs, 1H), 7.61 (d, 2H), 7.15 (d, 2H), 6.47 (s, 1H), 6.10 (bs, 1H), 4.86 (s, 2H), 2.64 (q, 2H), 2.38 (s, 6H), 1.22 (t, 3H).

EXAMPLE 2

Preparation of 3-(4,6-dimethyl-2-pyrimidinyl)-5-(4-ethylphenyl)-3,6-dihydro-2H-1,3,4-oxadiazine

A solution of 1.00 g (3.52 mmol) of 1-(4-ethylphenyl)-2-hydroxyethanone(4,6-dimethyl-2-pyrimidinyl)-hydrazone, 0.21 g (7.04 mmol) of paraformaldehyde, and a catalytic amount of butanesulfonic acid was heated at reflux for 3 h in 20 mL of acetonitrile. After cooling, the reaction mixture was diluted with dichloromethane and chloroform. The organic phase was washed successively with saturated sodium bicarbonate and brine, dried over sodium sulfate, filtered and concentrated. Chromatography on silica gel gave 70 mg of desired product as a gum. ¹H NMR (CDCl₃) δ 7.66 (d, 2H), 7.21 (d, 2H), 6.56 (s, 1H), 5.54 (s, 2H), 4.81 (s, 2H), 2.67 (q, 2H), 2.42 (s, 6H), 1.24 (t, 3H).

EXAMPLE 3

Preparation of 4-ethylbenzoic acid 2-(4,6-dimethyl-2-pyrimidinyl)hydrazide

4,6-Dimethyl-2-hydrazinopyrimidine (3.72 g, 26.95 mmol) was suspended in 80 mL of pyridine and the reaction mixture was cooled to 10°C. After slowly adding *p*-ethylbenzoyl chloride (5.00 g, 29.66 mmol), the reaction mixture was allowed to warm to room

temperature over 1 h. Addition of ice and water precipitated the product which was filtered and washed with hexanes to yield 6.85 g of a white solid. mp 118-119°C. ¹H NMR (CDCl₃) δ 9.15 (bs, 1H), 7.8 (d, 2H), 7.35 (bs, 1H), 7.2 (d, 2H), 6.52 (s, 1H), 2.7 (q, 2H), 2.33 (s, 6H), 1.23 (t, 3H).

EXAMPLE 4

Preparation of 4-(4,6-dimethyl-2-pyrimidinyl)-2-(4-ethylphenyl)-5,6-dihydro-4H-1,3,4-thiadiazine

10 A solution of 5.30 g (18.52 mmol) of 4-ethylbenzoic acid 2-(4,6-dimethyl-2-pyrimidinyl)hydrazide and 6.18 g (13.89 mmol) of P₂S₅ in 60 mL of pyridine was heated at reflux for 1.5 h. After cooling, water was added and the reaction mixture was heated briefly at reflux to
15 quench the reaction. The mixture was then cooled with an ice bath to precipitate the product. The solid was filtered and washed with water to give 6.57 g (21.73 mmol) of thiohydrazide which was then dissolved in 100 mL of THF with 7.5 mL (54.33 mmol) of triethyl-
20 amine and 2.1 mL (23.91 mmol) of 1,2-dibromoethane. The reaction mixture was heated at reflux overnight. After cooling, water and ether were added and the organic phase was separated and washed with brine. The organic extracts were dried over magnesium sulfate,
25 filtered and concentrated. The crude product was passed through a plug of silica gel to give 200 mg of product as an oil. ¹H NMR (CDCl₃), 7.8 (d, 2H), 7.2 (d, 2H), 6.53 (s, 1H), 4.45 (m, 2H), 3.35 (m, 2H), 2.67 (q, 2H), 2.41 (s, 6H), 1.22 (t, 3H).

30

EXAMPLE 5

Preparation of 4-(4,6-dimethyl-2-pyrimidinyl)-5,6-dihydro-2-(3-methylphenyl)-4H-1,3,4-oxadiazine

A solution of 1.00 g (3.89 mmol) of 3-methylbenzoic acid 2-(4,6-dimethyl-2-pyrimidinyl)hydrazide, 0.37 mL (4.28 mmol) of 1,2-dibromoethane, and 1.33 mL (8.95 mmol) of DBU in 20 mL of dry THF was heated at
35

reflux overnight. After cooling, 2.3 equivalents (8.95 mmol) of sodium hydride and 0.37 mL (4.28 mmol) of 1,2-dibromoethane were added, and the reaction mixture was heated at reflux overnight. The mixture was allowed to cool to room temperature and saturated aqueous ammonium chloride was added. The product was extracted with dichloromethane and chloroform and the organic phase was washed with brine. The organic extracts were dried over sodium sulfate, filtered, concentrated, and passed through a plug of silica gel to give 100 mg of desired product as a gum. ^1H NMR (CDCl_3) δ 7.82 (m, 1H), 7.75 (m, 1H), 7.25 (m, 1H), 7.19 (m, 1H), 6.49 (s, 1H), 4.54 (m, 2H), 4.28 (m, 2H), 2.42 (s, 6H), 2.38 (s, 3H).

15 EXAMPLE 6

Preparation of 4-methoxybenzenecarbothioic acid

O-[2-(4,6-dimethyl-2-pyrimidinyl)hydrazide

4,6-Dimethyl-2-hydrazinopyrimidine (*p*-methoxythiobenzoylthio)acetic acid (2.00 g, 14.49 mmol) and *p*-methoxyphenylcarboxymethyldithioate (3.48 g, 14.4 mmol) were dissolved in 20 mL of 1N aqueous sodium hydroxide and 10 mL of water. The reaction mixture was stirred at 25°C for 16 h and then acidified with 1N HCl. The resultant precipitate was filtered, washed with water, and dried under vacuum to give 3.22 g (11.2 mmol, 78%) of the title hydrazide as a white solid, m.p. 212-215°C ^1H NMR (CDCl_3) δ 9.5 (bs, 1H), 7.85 (d, 2H), 6.95 (d, 2H), 6.57 (s, 1H), 3.87 (s, 3H), 2.39 (s, 6H).

30 EXAMPLE 7

Preparation of 4-(4,6-dimethyl-2-pyrimidinyl)-

5,6-dihydro-2-phenyl-4H-1,3,4-thiadiazine

Benzenecarbothioic acid O-[2-(4,6-dimethyl-2-pyrimidinyl)]hydrazide (0.500 g, 1.94 mmol), triethylamine (4.85 mmol, 0.67 mL) and 1,2-dibromoethane (0.44 g, 2.33 mmol) were dissolved in

10 mL of THF and heated at reflux for 5 h. After cooling, water was added and the mixture was extracted with ethyl acetate. The organic layer was washed with brine, dried over sodium sulfate, filtered and concentrated. The product was purified by flash chromatography on silica gel to yield 0.490 g (1.73 mmol) of a solid in 89% yield, m.p. 138-142°C. ¹H NMR (CDCl₃) δ 7.88 (m, 2H), 7.37 (m, 3H), 6.55 (s, 1H), 4.47 (m, 2H), 3.36 (m, 2H), 2.42 (s, 6H).

10

EXAMPLE 8

Preparation of 4-(4,6-dimethyl-2-pyrimidinyl)-2-(4-ethylphenyl)-5,6-dihydro-4H-1,3,4-thiadiazine 1-oxide
4-(4,6-Dimethyl-2-pyrimidinyl)-2-(4-ethylphenyl)-5,6-dihydro-4H-1,3,4-thiadiazine (0.800 g, 2.56 mmol) was dissolved in 10 mL of methanol and 2.5 mL of water. Sodium metaperiodate (0.600 g, 2.82 mmol) was added and the reaction mixture was heated at reflux for 1 h. Ethanol (2.5 mL) was added and heating was continued for 1 h more. The reaction mixture was then stirred at 25°C for 16 h. An additional 200 mg of sodium metaperiodate was added and the mixture was heated at reflux for 1 h. The reaction mixture was washed with water and extracted with methylene chloride. The organic layers were washed with brine, dried over sodium sulfate, and concentrated. The crude product was passed through a plug of silica gel to give 760 mg (91% yield) of a white solid, m.p. 149-164°C. ¹H NMR (CDCl₃) δ 7.95 (d, 2H), 7.28 (d, 2H), 6.7 (s, 1H), 5.45 (m, 1H), 3.9 (m, 1H), 3.4 (m, 1H), 2.85 (m, 1H), 2.7 (q, 2H), 2.49 (s, 6H), 1.26 (t, 3H).

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EXAMPLE 9

Preparation of 4-(4,6-dimethyl-2-pyrimidinyl)-2-(4-ethylphenyl)-5,6-dihydro-4H-1,3,4-thiadiazine 1,1-dioxide
4-(4,6-Dimethyl-2-pyrimidinyl)-2-(4-ethylphenyl)-5,6-dihydro-4H-1,3,4-thiadiazine 1-oxide (0.350 g,

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1.06 mmol) was dissolved in 5 mL of methanol and 2.5 mL of water. The mixture was cooled to 0°C and Oxone® (potassium peroxymonosulfate) (0.490 g, 0.80 mmol) was added. The reaction was warmed to room temperature, stirred for 1 h, then heated at reflux for 10 min. After stirring at 25°C for 16 h, water was added and the reaction mixture was extracted twice with methylene chloride. The combined organic layers were washed with brine, dried over sodium sulfate, and concentrated. The crude product was passed through a plug of silica gel to yield 350 mg (96%) of a white solid, m.p. 139-141°C. ¹H NMR (CDCl₃) δ 7.90 (d, 2H), 7.27 (d, 2H), 6.72 (s, 1H), 5.05 (m, 2H), 3.55 (m, 2H), 2.67 (q, 2H), 2.47 (s, 6H), 1.24 (t, 3H).

15

EXAMPLE 10Preparation of 4-(4,6-dimethyl-2-pyrimidinyl)-
5,6-dihydro-2-phenoxy-4H-1,3,4-thiadiazine

O-Phenyl 2-(4,6-dimethyl-2-pyrimidinyl)hydrazine-carbothioate hydrochloride (4.00 g, 12.74 mmol) was dissolved in 38.5 mL of 1N aqueous sodium hydroxide, 40 mL of THF, and 1.31 mL (15.29 mmol) of 1,2-dibromoethane. The reaction mixture was stirred at 25°C for 4 days. Methylene chloride was added and the reaction was washed successively with water and brine. After drying over sodium sulfate and concentrating, the crude product was passed through a plug of silica gel to give 2.48 g (8.27 mmol, 65%) of a solid, m.p. 75-85°C. ¹H NMR (CDCl₃) δ 7.31 (m, 4H), 7.18 (m, 1H), 6.47 (s, 1H), 4.39 (m, 2H), 3.29 (m, 2H), 2.36 (s, 6H).

30

The compounds illustrated below are referred to in the tables which follow. G¹, G², G³, X, Y, E and R¹-R²⁸ are as defined for compounds of Formulae I-IV in the Summary of the Invention. In addition:

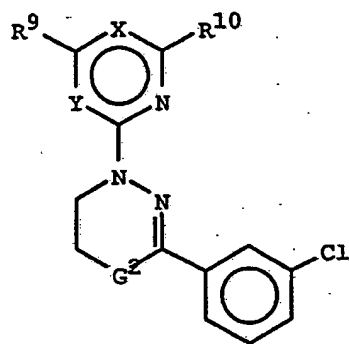
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n = 0-2, as in the disclosure (e.g., Equation 2);
n¹ = 1-3;

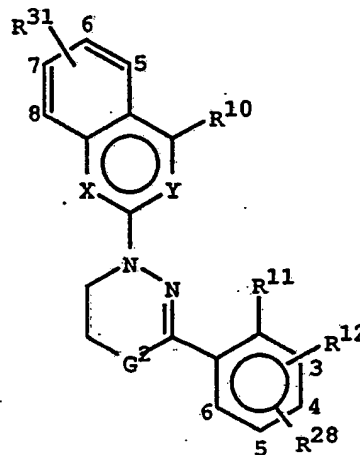
$$n^2 = 0-1;$$

MCl_x = the metal chloride salts of copper, zinc, iron, magnesium, or manganese; and

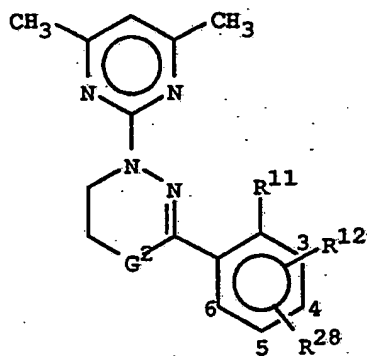
$$x = 1-2.$$



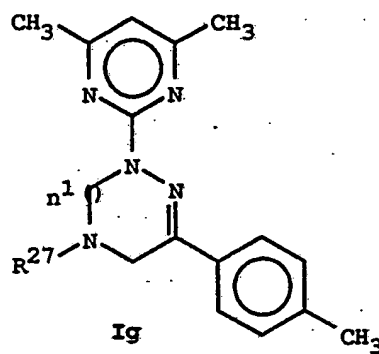
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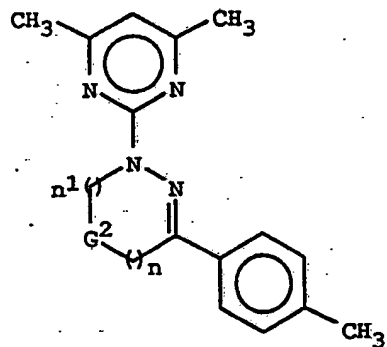
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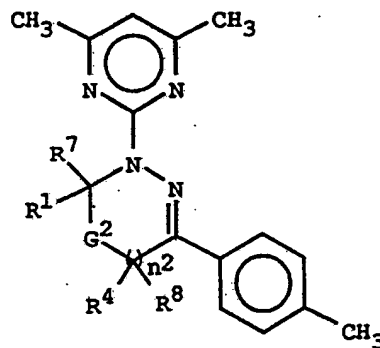
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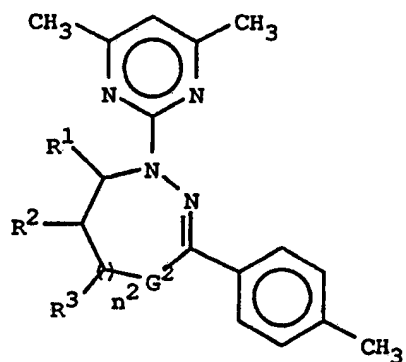
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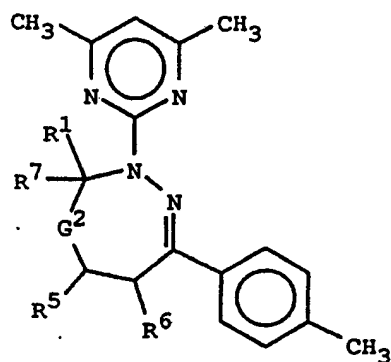
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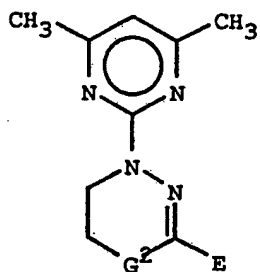
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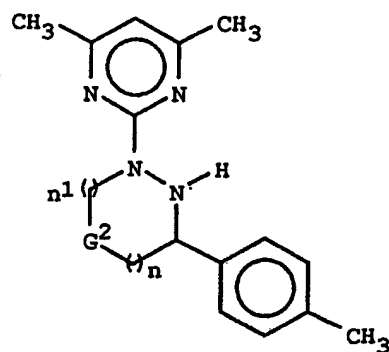
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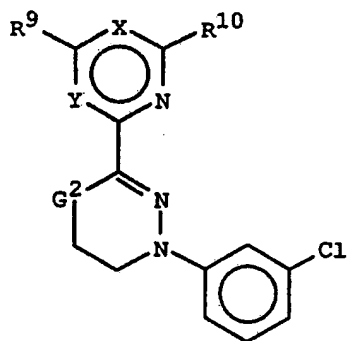
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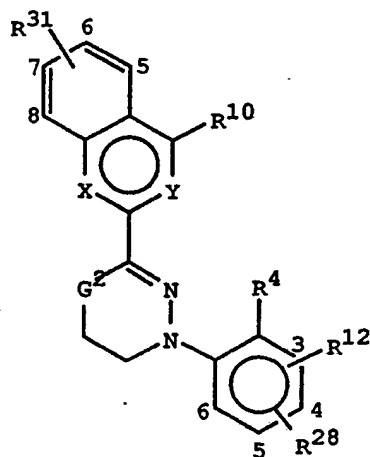
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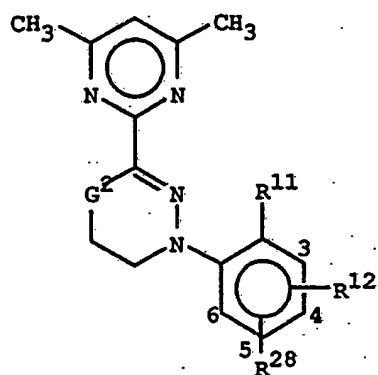
IIIc



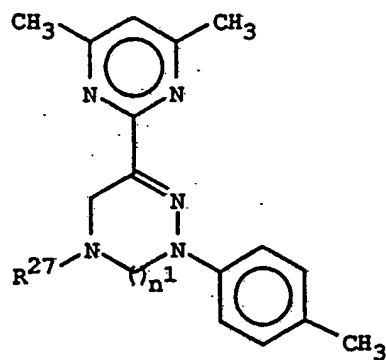
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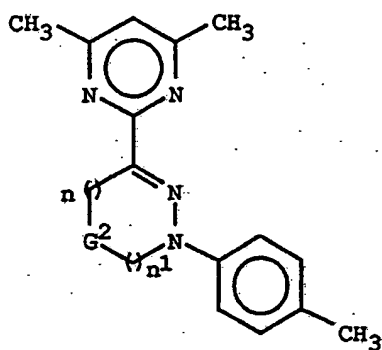
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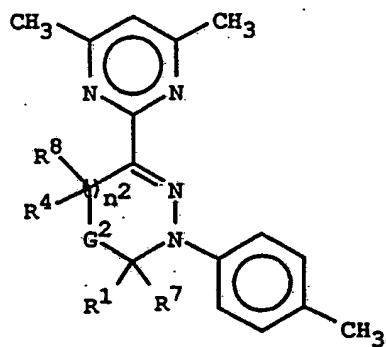
IIe



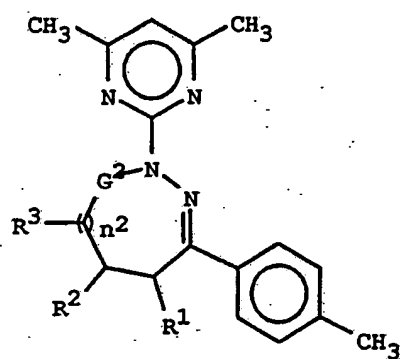
IIIf



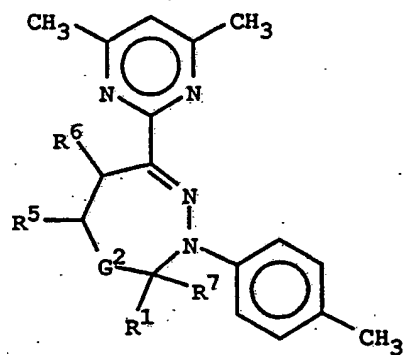
IIIf



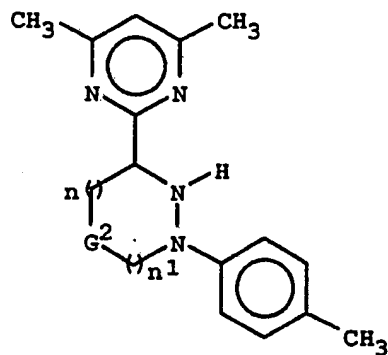
IIIf



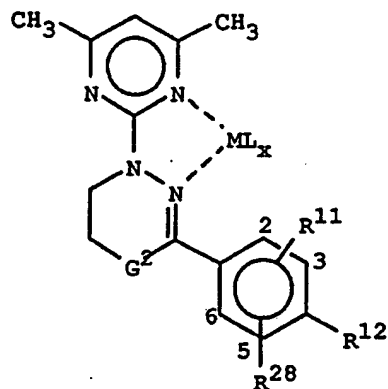
IIIf



IIIf



IVc

**Im**

The following abbreviations are used in the tables which follow. All alkyl groups are the normal isomers unless indicated otherwise.

t - is tertiary

s - is secondary

n - is normal

i - is iso

c - is cyclo

Me - is methyl

Et - is ethyl

Pr - is normal-propyl

Bu - is normal-butyl

Hex - is normal-hexyl

Ph - is phenyl

Bzl - is benzył

i-Pr - is isopropyl

t-Bu - is tertiary-butyl

c-Pr - is cyclopropyl

c-Hex - is cyclohexyl

s-Bu - is secondary-butyl

OMe - is methoxy

i-PrO - is isopropoxy

SEt - is ethylthio

CN - is cyano

TBS - is t-butyldimethylsilyl

Ac - is acetyl

S(O)Me - is methylsulfinyl

$\text{S(O)}_2\text{Me}$ - is methylsulfonyl

TABLE 1

Compounds of Formula Ia

$G^2=S$, $R^9=Me$, $Y=N$,	$OCH_2CH=CH_2$	$i-Pr$
$X=CH$	CH_2CH_2OMe	$c-Pr$
R^{10}	$OCHF_2$	$c-Hex$
H	$C\equiv CH$	$2-Me-c-Pr$
Cl	$C\equiv CCH_2CH_3$	CF_3
Br	$OCH_2C\equiv CH$	$(CH_2)_3CF_3$
F	NH_2	SMe
CN	NMe_2	SBu
OH	$NHEt$	$S(O)Me$
Me	4-morpholinyl	$S(O)Bu$
Hex	pyrrolidinyl	$S(O)_2Me$
Et	piperidinyl	$S(O)_2Bu$
$i-Pr$	Ph	OMe
$c-Pr$	PhO	OBu
$c-Hex$	4-Me-Ph	OCH_2CF_3
$2-Me-c-Pr$	3- CF_3 -Ph	$O(CH_2)_3CF_3$
CF_3	4- $i-Pr$ -PhO	CH_2OMe
$(CH_2)_3CF_3$	4- F_2HCO -Ph	$(CH_2)_3OMe$
SMe	3-Et-PhO	$CH=CHMe$
SBu	4-MeO-PhO	$CH=CHCH_2CH_3$
$S(O)Me$	4-MeO-Ph	$CH=CHCH_2CF_3$
$S(O)Bu$		$CH=CCl_2$
$S(O)_2Me$	$G^2=O$, $R^9=Me$, $Y=N$,	$OCH_2CH=CH_2$
$S(O)_2Bu$	$X=CH$	CH_2CH_2OMe
OMe	R^{10}	$OCHF_2$
OBu	H	$C\equiv CH$
OCH_2CF_3	Cl	$C\equiv CCH_2CH_3$
$O(CH_2)_3CF_3$	Br	$OCH_2C\equiv CH$
CH_2OMe	F	NH_2
$(CH_2)_3OMe$	CN	NMe_2
$CH=CHMe$	OH	$NHEt$
$CH=CHCH_2CH_3$	Me	4-morpholinyl
$CH=CHCH_2CF_3$	Hex	pyrrolidinyl
$CH=CCl_2$	Et	piperidinyl

Ph
PhO
4-Me-Ph
3-CF₃-Ph
4-*i*-Pr-PhO
4-F₂HCO-Ph
3-Et-PhO
4-MeO-PhO
4-MeO-Ph

G²=S, Y=N, X=CH,
R¹⁰=H
R⁹
H
Cl
Br
F
CN
OH
Me
Hex
Et
i-Pr
c-Pr
c-Hex
2-Me-*c*-Pr
CF₃
(CH₂)₃CF₃
SMe
SBu
S(O)Me
S(O)Bu
S(O)₂Me
S(O)₂Bu
OMe

OBu
OCH₂CF₃
O(CH₂)₃CF₃
CH₂OMe
(CH₂)₃OMe
CH=CHMe
CH=CHCH₂CH₃
CH=CHCH₂CF₃
CH=CCl₂
OCH₂CH=CH₂
CH₂CH₂OMe
OCHF₂
C≡CH
C≡CCH₂CH₃
OCH₂C≡CH
NH₂
NMe₂
NH₂Et
4-morpholinyl
pyrrolidinyl
piperidinyl
Ph
PhO
4-Me-Ph
3-CF₃-Ph
4-*i*-Pr-PhO
4-F₂HCO-Ph
3-Et-PhO
4-MeO-PhO
4-MeO-Ph

G²=S, R⁹=R¹⁰=Me,
X=CR¹³, Y=N
R¹³
H

Cl
Br
F
CN
OH
Me
Hex
Et
i-Pr
c-Pr
c-Hex
2-Me-*c*-Pr
CF₃
(CH₂)₃CF₃
SMe
SBu
S(O)Me
S(O)Bu
S(O)₂Me
S(O)₂Bu
OMe
OBu
OCH₂CF₃
O(CH₂)₃CF₃
CH₂OMe
(CH₂)₃OMe
CH=CHMe
CH=CHCH₂CH₃
CH=CHCH₂CF₃
CH=CCl₂
OCH₂CH=CH₂
CH₂CH₂OMe
OCHF₂
C≡CH
C≡CCH₂CH₃

$\text{OCH}_2\text{C}\equiv\text{CH}$
 NH_2
 NMe_2
 NHet
 4-morpholinyl
 pyrrolidinyl
 piperidinyl
 Ph
 PhO
 4-Me-Ph
 3- CF_3 -Ph
 4-i-Pr-PhO
 4- F_2HCO -Ph
 3-Et-PhO
 4-MeO-PhO
 4-MeO-Ph

$\text{G}^2=\text{S}$, $\text{R}^9=\text{R}^{10}=\text{Me}$,
 $\text{X}=\text{CH}$, $\text{Y}=\text{CR}^{14}$
 R^{14}

Cl
 Br
 F
 Me
 Et
 OMe
 OEt
 H

$\text{G}^2=\text{O}$, $\text{Y}=\text{N}$, $\text{X}=\text{CH}$,
 $\text{R}^{10}=\text{H}$
 R^9
 H
 Cl
 Br

F
 CN
 OH
 Me
 Hex
 Et
 i-Pr
 c-Pr
 c-Hex
 2-Me-c-Pr
 CF_3
 $(\text{CH}_2)_3\text{CF}_3$
 SMe
 SBu
 $\text{S}(\text{O})\text{Me}$
 $\text{S}(\text{O})\text{Bu}$
 $\text{S}(\text{O})_2\text{Me}$
 $\text{S}(\text{O})_2\text{Bu}$
 OMe
 OBu
 OCH_2CF_3
 $\text{O}(\text{CH}_2)_3\text{CF}_3$
 CH_2OMe
 $(\text{CH}_2)_3\text{OMe}$
 $\text{CH}=\text{CHMe}$
 $\text{CH}=\text{CHCH}_2\text{CH}_3$
 $\text{CH}=\text{CHCH}_2\text{CF}_3$
 $\text{CH}=\text{CCl}_2$
 $\text{OCH}_2\text{CH}=\text{CH}_2$
 $\text{CH}_2\text{CH}_2\text{OMe}$
 OCHF_2
 $\text{C}\equiv\text{CH}$
 $\text{C}\equiv\text{CCH}_2\text{CH}_3$
 $\text{OCH}_2\text{C}\equiv\text{CH}$
 NH_2

NMe_2
 NHet
 4-morpholinyl
 pyrrolidinyl
 piperidinyl
 Ph
 PhO
 4-Me-Ph
 3- CF_3 -Ph
 4-i-Pr-PhO
 4- F_2HCO -Ph
 3-Et-PhO
 4-MeO-PhO
 4-MeO-Ph

 $\text{G}^2=\text{O}$, $\text{R}^9=\text{R}^{10}=\text{Me}$,
 $\text{X}=\text{CR}^{13}$, $\text{Y}=\text{N}$
 R^{13}
 H
 Cl
 Br
 F
 CN
 OH
 Me
 Hex
 Et
 i-Pr
 c-Pr
 c-Hex
 2-Me-c-Pr
 CF_3
 $(\text{CH}_2)_3\text{CF}_3$
 SMe
 SBu

S(O)Me		Ph
S(O)Bu	$G^2=O$, $R^9=R^{10}=Me$,	PhO
S(O) ₂ Me	$X=CH$, $Y=CR^{14}$	4-Me-Ph
S(O) ₂ Bu	R^{14}	4-MeO-Ph
OMe	Cl	H
OBu	Br	
OCH ₂ CF ₃	F	$G^2=S$, $R^9=Me$, $Y=CH$,
O(CH ₂) ₃ CF ₃	Me	$X=N$
CH ₂ OMe	Et	R^{10}
(CH ₂) ₃ OMe	OMe	Cl
CH=CHMe	OEt	Br
CH=CHCH ₂ CH ₃	H	F
CH=CHCH ₂ CF ₃		CN
CH=CCl ₂	$G^2=S$, $R^9=Me$, $X=Y=N$	OH
OCH ₂ CH=CH ₂	R^{10}	Me
CH ₂ CH ₂ OMe	Cl	Et
OCHF ₂	Br	<i>i</i> -Pr
C≡CH	F	<i>c</i> -Pr
C≡CCH ₂ CH ₃	CN	CF ₃
OCH ₂ C≡CH	OH	SMe
NH ₂	Me	S(O)Me
NMe ₂	Et	S(O) ₂ Me
NHEt	<i>i</i> -Pr	OMe
4-morpholinyl	<i>c</i> -Pr	OEt
pyrrolidinyl	CF ₃	OCH ₂ OMe
piperidinyl	SMe	OCH ₂ CF ₃
Ph	S(O)Me	C=CHMe
PhO	S(O) ₂ Me	C≡CMe
4-Me-Ph	OMe	NMe ₂
3-CF ₃ -Ph	OEt	Ph
4- <i>i</i> -Pr-PhO	OCH ₂ OMe	PhO
4-F ₂ HCO-Ph	OCH ₂ CF ₃	4-Me-Ph
3-Et-PhO	C=CHMe	4-MeO-Ph
4-MeO-PhO	C≡CMe	H
4-MeO-Ph	NMe ₂	

$G^2=O$, $R^9=Me$, $X=Y=N$ R^{10}

Cl

Br

F

CN

OH

Me

Et

i-Pr*c*-Pr CF_3

SMe

S(O)Me

S(O)₂Me

OMe

OEt

OCH₂OMeOCH₂CF₃

C=CHMe

C≡CMe

NMe₂

Ph

PhO

4-Me-Ph

4-MeO-Ph

H

 $G^2=O$, $R^9=Me$, $Y=CH$, $X=N$ R^{10}

Cl

Br

F

CN

OH

Me

Et

i-Pr*c*-Pr CF_3

SMe

S(O)Me

S(O)₂Me

OMe

OEt

OCH₂OMeOCH₂CF₃

C=CHMe

C≡CMe

NMe₂

Ph

PhO

4-Me-Ph

4-MeO-Ph

H

 $G^2=S$

X

Y

 R^{14} R^9 R^{13} R^{10}

N

CR¹⁴-(CH₂)₃-

--

Me

CH

CR¹⁴-(CH₂)₃-

--

Me

N

CR¹⁴-(CH₂)₄-

--

Me

CH

CR¹⁴-(CH₂)₄-

--

Me

CR¹³

N

--

-(CH₂)₃-

Me

CR¹³

CH

--

-(CH₂)₃-

Me

CR¹³

N

--

-(CH₂)₄-

Me

CR¹³

CH

--

-(CH₂)₄-

Me

CR¹³

CH

--

Me

-(CH₂)₃-CR¹³

CH

--

Me

-(CH₂)₄-

$G^2=O$

X	Y	R ¹⁴	R ⁹	R ¹³	R ¹⁰
N	CR ¹⁴	-(CH ₂) ₃ -		--	Me
CH	CR ¹⁴	-(CH ₂) ₃ -		--	Me
N	CR ¹⁴	-(CH ₂) ₄ -		--	Me
CH	CR ¹⁴	-(CH ₂) ₄ -		--	Me
CR ¹³	N	--	-(CH ₂) ₃ -		Me
CR ¹³	CH	--	-(CH ₂) ₃ -		Me
CR ¹³	N	--	-(CH ₂) ₄ -		Me
CR ¹³	CH	--	-(CH ₂) ₄ -		Me
CR ¹³	CH	--	Me	-(CH ₂) ₃ -	
CR ¹³	CH	--	Me	-(CH ₂) ₄ -	

TABLE 2

Compounds of Formula Ia

 $G^2=S$, $X=Y=N$, $R^{11}=R^{12}=R^{28}=H$

R ¹⁰		
Cl	c-Pr	C=CHMe
Br	CF ₃	C=CMe
F	SMe	NMe ₂
CN	S(O)Me	Ph
OH	S(O) ₂ Me	PhO
Me	OMe	4-Me-Ph
Et	OEt	4-MeO-Ph
i-Pr	OCH ₂ OMe	H
	OCH ₂ CF ₃	

 $G^2=S$

X	Y	R ¹⁰	R ¹¹	R ¹²	R ²⁸	R ³¹
CH	N	Me	H	H	H	H
N	CH	Me	H	H	H	H
N	N	Me	H	3-Me	4-Me	H
N	N	Me	H	3-Me	4-Me	6-Me
N	N	Me	Me	H	H	7-Me

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N	N	Me	H	H	4- <i>i</i> -Pr	6-OMe
N	N	Me	H	3-Me	H	7-CF ₃
N	N	Me	H	H	4-Et	7-Et
N	N	Me	H	H	4- <i>i</i> -Pr	6-OCHF ₂
N	N	Me	H	H	H	8-Bu
N	N	Me	H	H	4- <i>c</i> -Pr	6-OEt

G²=O, X=Y=N, R¹¹=R¹²=R²⁸=H

R ¹⁰	<i>c</i> -Pr	C=CHMe
Cl	CF ₃	C=OMe
Br	SMe	NMe ₂
F	S(O)Me	Ph
CN	S(O) ₂ Me	PhO
OH	OMe	4-Me-Ph
Me	OEt	4-MeO-Ph
Et	OCH ₂ OMe	H
<i>i</i> -Pr	OCH ₂ CF ₃	

G²=O

X	Y	R ¹⁰	R ¹¹	R ¹²	R ²⁸	R ³¹
CH	N	Me	H	H	H	H
N	CH	Me	H	H	H	H
N	N	Me	H	3-Me	4-Me	H
N	N	Me	H	3-Me	4-Me	6-Me
N	N	Me	Me	H	H	7-Me
N	N	Me	H	H	4- <i>i</i> -Pr	6-OMe
N	N	Me	H	3-Me	H	7-CF ₃
N	N	Me	H	H	4-Et	7-Et
N	N	Me	H	H	4- <i>i</i> -Pr	6-OCHF ₂
N	N	Me	H	H	H	8-Bu
N	N	Me	H	H	4- <i>c</i> -Pr	6-OEt

TABLE 3

Compounds of Formula If

$G^2=S$, $R^{12}=H$, $R^{28}=H$	$G^2=S$, $R^{11}=R^{12}=H$	$4-C\equiv CH$
R^{11}	R^{28}	$4-C\equiv C-Et$
H	4-Me	$4-OCH_2C\equiv CH$
Me	4-CN	4-NMe ₂
Et	4-NO ₂	4-C(=O)NMe ₂
<i>i</i> -Pr	4-OH	4-Ph
<i>s</i> -Bu	4-CO ₂ H	4-OPh
F	4-CO ₂ Et	4-SPh
Cl	4-Et	4-(3-Me-Ph)
Br	4- <i>i</i> -Pr	
CF ₃	4- <i>n</i> -Hex	$G^2=S$
OMe	4- <i>c</i> -Pr	R^{11} R^{12} R^{28}
OEt	4-CF ₃	Cl H 6-Cl
OCHF ₂	4-SMe	H 3-Me 4-Me
OBu	4-SBu	H 3-Me 4-Et
O(CH ₂) ₃ CF ₃	4- <i>c</i> -Hex	H 3-OMe 4-OMe
(CH ₂) ₃ CF ₃	4-Cl	Me H 5-Me
$G^2=S$, $R^{11}=H$, $R^{28}=H$	4-Br	Me H 4-Me
R^{12}	4-F	Me 4-Me 5-Me
3-Me	4-(CH ₂) ₃ CF ₃	H 3-Cl 5-Cl
3-Et	4-S(O)Me	Cl H 4-Cl
3- <i>i</i> -Pr	4-S(O)Bu	
3- <i>s</i> -Bu	4-S(O) ₂ Me	$G^2=O$, $R^{12}=H$, $R^{28}=H$
3-F	4-S(O) ₂ Bu	R^{11}
3-Cl	4-OMe	H
3-Br	4-OBu	Me
3-CF ₃	4-OCH ₂ CF ₃	Et
3-OMe	4-OCH ₂ OMe	<i>i</i> -Pr
3-OEt	4-CH ₂ OMe	<i>s</i> -Bu
3-OCHF ₂	4-CH=CH-Me	F
3-OBu	4-CH=CHCH ₂ Me	Cl
3-O(CH ₂) ₃ CF ₃	4-TBS	Br
3-(CH ₂) ₃ CF ₃	4-SiMe ₃	CF ₃

OMe
OEt
OCHF₂
OBu
O(CH₂)₃CF₃
(CH₂)₃CF₃

G²=O, R¹¹=H, R²⁸=H
R¹²
3-Me
3-Et
3-*i*-Pr
3-*s*-Bu
3-F
3-Cl
3-Br
3-CF₃
3-OMe
3-OEt
3-OCHF₂
3-OBu
3-O(CH₂)₃CF₃
3-(CH₂)₃CF₃

G²=O, R¹¹=R¹²=H
R²⁸
4-Me
4-CN
4-NO₂
4-OH
4-CO₂H
4-CO₂Et
4-Et
4-*i*-Pr
4-*n*-Hex

4-*c*-Pr
4-CF₃
4-SMe
4-SBu
4-*c*-Hex
4-Cl
4-Br
4-F
4-(CH₂)₃CF₃
4-S(O)Me
4-S(O)Bu
4-S(O)₂Me
4-S(O)₂Bu
4-OMe
4-OBu
4-OCH₂CF₃
4-OCH₂OMe
4-CH₂OMe
4-CH=CH-Me
4-CH=CHCH₂Me
4-TBS
4-SiMe₃
4-C≡CH
4-C≡C-Et
4-OCH₂C≡CH
4-NMe₂
4-C(=O)NMe₂
4-Ph
4-OPh
4-SPh
4-(3-Me-Ph)

G²=O
R¹¹ R¹² R²⁸
Cl H 6-Cl

H 3-Me 4-Me
H 3-Me 4-Et
H 3-OMe 4-OMe
Me H 5-Me
Me H 4-Me
Me 4-Me 5-Me
H 3-Cl 5-Cl
Cl H 4-Cl

G²=S(O), R¹²=H,
R²⁸=H
R¹¹
H
Me
Et
i-Pr
s-Bu
F
Cl
Br
CF₃
OMe
OEt
OCHF₂
OBu
O(CH₂)₃CF₃
(CH₂)₃CF₃

G²=S(O), R¹¹=H,
R²⁸=H
R¹²
3-Me
3-Et
3-*i*-Pr
3-*s*-Bu

3-F
 3-Cl
 3-Br
 3-CF₃
 3-OMe
 3-OEt
 3-OCHF₂
 3-OBu
 3-O(CH₂)₃CF₃
 3-(CH₂)₃CF₃

 G²=S(O), R¹¹=R¹²=H
 R²⁸
 4-Me
 4-CN
 4-NO₂
 4-OH
 4-CO₂H
 4-CO₂Et
 4-Et
 4-*i*-Pr
 4-*n*-Hex
 4-*c*-Pr
 4-CF₃
 4-SMe
 4-SBu
 4-*c*-Hex
 4-Cl
 4-Br
 4-F
 4-(CH₂)₃CF₃
 4-S(O)Me
 4-S(O)Bu
 4-S(O)₂Me
 4-S(O)₂Bu

4-OMe
 4-OBu
 4-OCH₂CF₃
 4-OCH₂OMe
 4-CH₂OMe
 4-CH=CH-Me
 4-CH=CHCH₂Me
 4-TBS
 4-SiMe₃
 4-C≡CH
 4-C≡C-Et
 4-OCH₂C≡CH
 4-NMe₂
 4-C(=O)NMe₂
 4-Ph
 4-OPh
 4-SPh
 4-(3-Me-Ph)

 G²=S(O)
 R¹¹ R¹² R²⁸
 Cl H 6-Cl
 H 3-Me 4-Me
 H 3-Me 4-Et
 H 3-OMe 4-OMe
 Me H 5-Me
 Me H 4-Me
 Me 4-Me 5-Me
 H 3-Cl 5-Cl
 Cl H 4-Cl

 G²=S(O)₂, R¹²=H,
 R²⁸=H
 R¹¹
 H

Me
 Et
i-Pr
s-Bu
 F
 Cl
 Br
 CF₃
 OMe
 OEt
 OCHF₂
 OBu
 O(CH₂)₃CF₃
 (CH₂)₃CF₃

 G²=S(O)₂, R¹¹=H,
 R²⁸=H
 R¹²
 3-Me
 3-Et
 3-*i*-Pr
 3-*s*-Bu
 3-F
 3-Cl
 3-Br
 3-CF₃
 3-OMe
 3-OEt
 3-OCHF₂
 3-OBu
 3-O(CH₂)₃CF₃
 3-(CH₂)₃CF₃

G²=S(O)₂,R¹¹=R¹²=HR²⁸

4-Me

4-CN

4-NO₂

4-OH

4-CO₂H4-CO₂Et

4-Et

4-*i*-Pr4-*n*-Hex4-*c*-Pr4-CF₃

4-SMe

4-SBu

4-*c*-Hex

4-Cl

4-Br

4-F

4-(CH₂)₃CF₃

4-S(O)Me

4-S(O)Bu

4-S(O)₂Me4-S(O)₂Bu

4-OMe

4-OBu

4-OCH₂CF₃4-OCH₂OMe4-CH₂OMe

4-CH=CH-Me

4-CH=CHCH₂Me

4-TBS

4-SiMe₃

4-C≡CH

4-C≡C-Et

4-OCH₂C≡CH4-NMe₂4-C(=O)NMe₂

4-Ph

4-OPh

4-SPh

4-(3-Me-Ph)

G²=S(O)₂R¹¹ R¹² R²⁸

Cl H 6-Cl

H 3-Me 4-Me

H 3-Me 4-Et

H 3-OMe 4-OMe

Me H 5-Me

Me H 4-Me

Me 4-Me 5-Me

H 3-Cl 5-Cl

Cl H 4-Cl

TABLE 4

Compounds of Formula Ig

$n^1=1$	Et
R^{27}	Bu
H	<i>i</i> -Pr
Et	CHF_2
Bu	$(CH_2)_3CF_3$
<i>i</i> -Pr	CO_2Et
CHF_2	$C(=O)Me$
$(CH_2)_3CF_3$	$C(=O)(CH_2)_3Me$
CO_2Et	$C(=O)Ph$
$C(=O)Me$	$(3-Me-Ph)C(=O)$
$C(=O)(CH_2)_3Me$	$(4-OMe-Ph)C(=O)$
$C(=O)Ph$	$CH_2C=CH_2$
$(3-Me-Ph)C(=O)$	$CH_2C\equiv CH$
$(4-OMe-Ph)C(=O)$	$PhCH_2$
$CH_2C=CH_2$	$4-Me-PhCH_2$
$CH_2C\equiv CH$	$S(O)_2Me$
$PhCH_2$	$C(=O)NMe_2$
$4-Me-PhCH_2$	$C(=S)NHMe$
$S(=O)_2Me$	$S(O)Me$
$C(=O)NMe_2$	$S(O)_2Ph$
$C(=S)NHMe$	$(4-Me-Ph)S(O)_2$
$S(O)Me$	$C(=O)NHPh$
$S(O)_2Ph$	$C(=S)NHPh$
$(4-Me-Ph)S(O)_2$	$P(=S)(OEt)_2$
$C(=O)NHPh$	$P(=O)(OEt)_2$
$C(=S)NHPh$	$S(O)_2N(Et)_2$
$P(=S)(OEt)_2$	
$P(=O)(OEt)_2$	$n^1=3$
$S(O)_2N(Et)_2$	R^{27}
$n^1=2$	H
	Et
R^{27}	Bu
H	<i>i</i> -Pr

CHF_2
 $(\text{CH}_2)_3\text{CF}_3$
 CO_2Et
 $\text{C}(=\text{O})\text{Me}$
 $\text{C}(=\text{O})(\text{CH}_2)_3\text{Me}$
 $\text{C}(=\text{O})\text{Ph}$
 $(3\text{-Me-Ph})\text{C}(=\text{O})$
 $(4\text{-OMe-Ph})\text{C}(=\text{O})$
 $\text{CH}_2\text{C}=\text{CH}_2$
 $\text{CH}_2\text{C}\equiv\text{CH}$
 PhCH_2
 4-Me-PhCH_2
 $\text{S}(\text{O})_2\text{Me}$
 $\text{C}(=\text{O})\text{NMe}_2$
 $\text{C}(=\text{S})\text{NHMe}$
 $\text{S}(\text{O})\text{Me}$
 $\text{S}(\text{O})_2\text{Ph}$
 $(4\text{-Me-Ph})\text{S}(\text{O})_2$
 $\text{C}(=\text{O})\text{NHPh}$
 $\text{C}(=\text{S})\text{NHPh}$
 $\text{P}(=\text{S})(\text{OEt})_2$
 $\text{P}(=\text{O})(\text{OEt})_2$
 $\text{S}(\text{O})_2\text{N}(\text{Et})_2$

TABLE 5

Compounds of Formula Ia

n	n ¹	G ²
1	1	S
1	2	S
2	1	S
0	3	S
1	1	O
1	2	O
2	1	O
0	3	O

1	1	S(O)
1	2	S(O)
2	1	S(O)
0	3	S(O)
1	1	S(O) ₂
1	2	S(O) ₂
2	1	S(O) ₂
0	3	S(O) ₂
1	1	N-Me
1	2	N-Me
2	1	N-Me

TABLE 6

Compounds of Formula II

G²=S

n ²	R ¹	R ⁷	R ⁴	R ⁸
1	Me	H	H	H
1	Bu	H	H	H
1	Me	Me	H	H
1	H	H	Me	H
1	H	H	Bu	H
1	Ph	H	H	H
1	4-Me-Ph	H	H	H
1	4-OMe-Ph	H	H	H
0	Me	H	--	--
0	Bu	H	--	--
0	Me	Me	--	--
0	Ph	H	--	--
0	4-Me-Ph	H	--	--

G²=O

n ²	R ¹	R ⁷	R ⁴	R ⁸
1	Me	H	H	H
1	Bu	H	H	H
1	Me	Me	H	H

1	H	H	Me	H
1	H	H	Bu	H
1	Ph	H	H	H
1	4-Me-Ph	H	H	H
1	4-OMe-Ph	H	H	H
0	Me	H	--	--
0	Bu	H	--	--
0	Me	Me	--	--
0	Ph	H	--	--
0	4-Me-Ph	H	--	--

TABLE 7

Compounds of Formula Ij

$G^2=S$			
n^2	R^1	R^2	R^3
0	Me	H	--
0	Bu	H	--
0	H	Me	--
0	H	Bu	--
0	Ph	H	--
0	4-Me-Ph	H	--
0	H	4-OMe-Ph	--
1	Me	H	H
1	Bu	H	H
1	H	Me	H
1	H	Bu	H
1	H	H	Me
1	H	H	Bu
1	Ph	H	H

1	4-Me-Ph	H	H
1	H	Ph	H
1	H	4-Me-Ph	H
1	H	H	Ph
1	H	H	4-Me-Ph

 $G^2=O$

n^2	R^1	R^2	R^3
0	Me	H	--
0	Bu	H	--
0	H	Me	--
0	H	Bu	--
0	Ph	H	--
0	4-Me-Ph	H	--
0	H	4-OMe-Ph	--
1	Me	H	H
1	Bu	H	H
n^2	R^1	R^2	R^3
1	H	Me	H
1	H	Bu	H
1	H	H	Me
1	H	H	Bu
1	Ph	H	H
n^2	R^1	R^2	R^3
1	4-Me-Ph	H	H
1	H	Ph	H
1	H	4-Me-Ph	H
1	H	H	Ph
1	H	H	4-Me-Ph

TABLE 8

Compounds of Formula Ik

$G^2=S$			
R^1	R^7	R^5	R^6
H	H	Me	H

H	H	Ph	H
H	H	H	Me
H	H	H	Ph

Me	H	H	H	Ph	H	H	H
Me	Me	H	H	H	Ph	H	H
Ph	H	H	H	H	H	Bu	H
H	Ph	H	H	H	H	4-Me-Ph	H
H	H	Bu	H	H	H	H	Bu
H	H	4-Me-Ph	H	H	H	H	4-OMe-Ph
H	H	H	Bu	Bu	H	H	H
H	H	H	4-OMe-Ph	3-Me-Ph	H	H	H
Bu	H	H	H	4-OMe-Ph	H	H	H
3-Me-Ph	H	H	H				
4-OMe-Ph	H	H	H				
$G^2=O$							
R^1	R^7	R^5	R^6				
H	H	Me	H				
H	H	Ph	H				
H	H	H	Me				
H	H	H	Ph				
Me	H	H	H				
Me	Me	H	H				

TABLE 9

Compounds of Formula II

$G^2=S$	3-thienyl
E	2,5-diMe-3-furanyl
H	2,5-diMe-3-thienyl
Me	4-Me-PhO
n-Hex	2-Cl-PhO
c-Hex	2,6-diMe-PhO
PhCH ₂	4-Me-PhNH
CH ₂ CH ₂ CF ₃	3-Me-PhS
OBu	s-BuS
O(CH ₂) ₅ Cl	1-indanyl
1-naphthalenyl	5-Me-2-thienyl
2-naphthalenyl	5-Me-2-pyridyl
2-furanyl	4-Me-3-furanyl

2-Me-3-pyridyl

 $G^2=O$

E

H

Me

n-Hex

c-Hex

PhCH₂CH₂CH₂CF₃

OBu

O(CH₂)₅Cl

1-naphthalenyl

2-naphthalenyl

2-furanyl

3-thienyl

2,5-diMe-3-furanyl

2,5-diMe-3-thienyl

4-Me-PhO

2-Cl-PhO

2,6-diMe-PhO

4-Me-PhNH

3-Me-PhS

s-BuS

1-indanyl

5-Me-2-thienyl

5-Me-2-pyridyl

4-Me-3-furanyl

2-Me-3-pyridyl

 $G^2=S(O)$

E

H

Me

n-Hex

c-Hex

PhCH₂CH₂CH₂CF₃

OBu

O(CH₂)₅Cl

1-naphthalenyl

2-naphthalenyl

2-furanyl

3-thienyl

2,5-diMe-3-furanyl

2,5-diMe-3-thienyl

4-Me-PhO

2-Cl-PhO

2,6-diMe-PhO

4-Me-PhNH

3-Me-PhS

s-BuS

1-indanyl

5-Me-2-thienyl

5-Me-2-pyridyl

4-Me-3-furanyl

2-Me-3-pyridyl

 $G^2=S(O)_2$

E

H

Me

n-Hex

c-Hex

PhCH₂CH₂CH₂CF₃

OBu

O(CH₂)₅Cl

1-naphthalenyl

2-naphthalenyl

2-furanyl	3-Me-PhS
3-thienyl	s-BuS
2,5-diMe-3-furanyl	1-indanyl
2,5-diMe-3-thienyl	5-Me-2-thienyl
4-Me-PhO	5-Me-2-pyridyl
2-Cl-PhO	4-Me-3-furanyl
2,6-diMe-PhO	2-Me-3-pyridyl
4-Me-PhNH	

TABLE 10

Compounds of Formula IIIc

G ²	n	n ¹	S(O)	1	1
S	0	1	S(O)	1	2
S	0	2	S(O)	2	1
S	0	3	S(O) ₂	0	1
S	1	1	S(O) ₂	0	2
S	1	2	S(O) ₂	0	3
S	2	1	S(O) ₂	1	1
O	0	1	S(O) ₂	1	2
O	0	2	S(O) ₂	2	1
O	0	3	NMe	0	1
O	1	1	NMe	0	2
O	1	2	NMe	0	3
O	2	1	NMe	1	1
S(O)	0	1	NMe	1	2
S(O)	0	2	NMe	2	1
S(O)	0	3			

TABLE 11

Compounds of Formula IIc

G ² =S, R ⁹ =Me, Y=N,	Br	Hex
X=CH	F	Et
R ¹⁰	CN	i-Pr
H	OH	c-Pr
Cl	Me	c-Hex

2-Me-c-Pr	4-i-Pr-PhO	(CH ₂) ₃ OMe
CF ₃	4-F ₂ HCO-Ph	CH=CHMe
(CH ₂) ₃ CF ₃	3-Et-PhO	CH=CHCH ₂ CH ₃
SMe	4-MeO-PhO	CH=CHCH ₂ CF ₃
SBu	4-MeO-Ph	CH=CCl ₂
S(O)Me		OCH ₂ CH=CH ₂
S(O)Bu	G ² =O, R ⁹ =Me, Y=N,	CH ₂ CH ₂ OMe
S(O) ₂ Me	X=CH	OCHF ₂
S(O) ₂ Bu	R ¹⁰	C≡CH
OMe	H	C≡CCH ₂ CH ₃
OBu	Cl	OCH ₂ C≡CH
OCH ₂ CF ₃	Br	NH ₂
O(CH ₂) ₃ CF ₃	F	NMe ₂
CH ₂ OMe	CN	NHET
(CH ₂) ₃ OMe	OH	4-morpholinyl
CH=CHMe	Me	pyrrolidinyl
CH=CHCH ₂ CH ₃	Hex	piperidinyl
CH=CHCH ₂ CF ₃	Et	Ph
CH=CCl ₂	i-Pr	PhO
OCH ₂ CH=CH ₂	c-Pr	4-Me-Ph
CH ₂ CH ₂ OMe	c-Hex	3-CF ₃ -Ph
OCHF ₂	2-Me-c-Pr	4-i-Pr-PhO
C≡CH	CF ₃	4-F ₂ HCO-Ph
C≡CCH ₂ CH ₃	(CH ₂) ₃ CF ₃	3-Et-PhO
OCH ₂ C≡CH	SMe	4-MeO-PhO
NH ₂	SBu	4-MeO-Ph
NMe ₂	S(O)Me	
NHET	S(O)Bu	G ² =S, Y=N, X=CH,
4-morpholinyl	S(O) ₂ Me	R ¹⁰ =H
pyrrolidinyl	S(O) ₂ Bu	R ⁹
piperidinyl	OMe	H
Ph	OBu	Cl
PhO	OCH ₂ CF ₃	Br
4-Me-Ph	O(CH ₂) ₃ CF ₃	F
3-CF ₃ -Ph	CH ₂ OMe	CN

OH	4-morpholinyl	S(O) ₂ Me
Me	pyrrolidinyl	S(O) ₂ Bu
Hex	piperidinyl	OMe
Et	Ph	OBu
i-Pr	PhO	OCH ₂ CF ₃
c-Pr	4-Me-Ph	O(CH ₂) ₃ CF ₃
c-Hex	3-CF ₃ -Ph	CH ₂ OMe
2-Me-c-Pr	4-i-Pr-PhO	(CH ₂) ₃ OMe
CF ₃	4-F ₂ HCO-Ph	CH=CHMe
(CH ₂) ₃ CF ₃	3-Et-PhO	CH=CHCH ₂ CH ₃
SMe	4-MeO-PhO	CH=CHCH ₂ CF ₃
SBu	4-MeO-Ph	CH=CCl ₂
S(O)Me		OCH ₂ CH=CH ₂
S(O)Bu	G ² =S, R ⁹ =R ¹⁰ =Me,	CH ₂ CH ₂ OMe
S(O) ₂ Me	X=CR ¹³ , Y=N	OCHF ₂
S(O) ₂ Bu	R ¹³	C≡CH
OMe	H	C≡CCH ₂ CH ₃
OBu	Cl	OCH ₂ C≡CH
OCH ₂ CF ₃	Br	NH ₂
O(CH ₂) ₃ CF ₃	F	NMe ₂
CH ₂ OMe	CN	NHEt
(CH ₂) ₃ OMe	OH	4-morpholinyl
CH=CHMe	Me	pyrrolidinyl
CH=CHCH ₂ CH ₃	Hex	piperidinyl
CH=CHCH ₂ CF ₃	Et	Ph
CH=CCl ₂	i-Pr	PhO
OCH ₂ CH=CH ₂	c-Pr	4-Me-Ph
CH ₂ CH ₂ OMe	c-Hex	3-CF ₃ -Ph
OCHF ₂	2-Me-c-Pr	4-i-Pr-PhO
C≡CH	CF ₃	4-F ₂ HCO-Ph
C≡CCH ₂ CH ₃	(CH ₂) ₃ CF ₃	3-Et-PhO
OCH ₂ C≡CH	SMe	4-MeO-PhO
NH ₂	SBu	4-MeO-Ph
NMe ₂	S(O)Me	
NHEt	S(O)Bu	

$G^2=S, R^9=R^{10}=Me,$
 $X=CH, Y=CR^{14}$
 R^{14}

Cl

Br

F

Me

Et

OMe

OEt

H

 $G^2=O, Y=N, X=CH,$
 $R^{10}=H$
 R^9

H

Cl

Br

F

CN

OH

Me

Hex

Et

i-Pr

c-Pr

c-Hex

2-Me-c-Pr

 CF_3
 $(CH_2)_3CF_3$

SMe

SBu

S(O)Me

S(O)Bu

S(O)₂MeS(O)₂Bu

OMe

OBu

OCH₂CF₃O(CH₂)₃CF₃CH₂OMe(CH₂)₃OMe

CH=CHMe

CH=CHCH₂CH₃CH=CHCH₂CF₃CH=CCl₂OCH₂CH=CH₂CH₂CH₂OMeOCHF₂

C≡CH

C≡CCH₂CH₃OCH₂C≡CHNH₂NMe₂NH₂Et

4-morpholinyl

pyrrolidinyl

piperidinyl

Ph

PhO

4-Me-Ph

3-CF₃-Ph

4-i-Pr-PhO

4-F₂HCO-Ph

3-Et-PhO

4-MeO-PhO

4-MeO-Ph

 $G^2=O, R^9=R^{10}=Me,$
 $X=CR^{13}, Y=N$
 R^{13}

H

Cl

Br

F

CN

OH

Me

Hex

Et

i-Pr

c-Pr

c-Hex

2-Me-c-Pr

 CF_3
 $(CH_2)_3CF_3$

SMe

SBu

S(O)Me

S(O)Bu

S(O)₂MeS(O)₂Bu

OMe

OBu

OCH₂CF₃O(CH₂)₃CF₃CH₂OMe(CH₂)₃OMe

CH=CHMe

CH=CHCH₂CH₃CH=CHCH₂CF₃CH=CCl₂OCH₂CH=CH₂CH₂CH₂OMeOCHF₂

$C\equiv CH$
 $C\equiv CCH_2CH_3$
 $OCH_2C\equiv CH$
 NH_2
 NMe_2
 $NHEt$
 4-morpholinyl
 pyrrolidinyl
 piperidinyl
 Ph
 PhO
 4-Me-Ph
 3-CF₃-Ph
 4-*i*-Pr-PhO
 4-F₂HCO-Ph
 3-Et-PhO
 4-MeO-PhO
 4-MeO-Ph

$G^2=O$, $R^9=R^{10}=Me$,

$X=CH$, $Y=CR^{14}$

R^{14}

Cl

Br

F

Me

Et

OMe

OEt

H

$G^2=S$, $R^9=Me$, $X=Y=N$

R^{10}

Cl

Br

F
 CN
 OH
 Me
 Et
i-Pr
c-Pr
 CF₃
 SMe
 S(O)Me
 S(O)₂Me
 OMe
 OEt
 OCH₂OMe
 OCH₂CF₃
 C=CHMe
 C=CMMe
 NMe₂
 Ph
 PhO
 4-Me-Ph
 4-MeO-Ph
 H

$G^2=S$, $R^9=Me$, $Y=CH$,

$X=N$

R^{10}

Cl

Br

F

CN

OH

Me

Et

i-Pr

c-Pr
 CF₃
 SMe
 S(O)Me
 S(O)₂Me
 OMe
 OEt
 OCH₂OMe
 OCH₂CF₃
 C=CHMe
 C=CMMe
 NMe₂
 Ph
 PhO
 4-Me-Ph
 4-MeO-Ph
 H

$G^2=O$, $R^9=Me$, $X=Y=N$

R^{10}

Cl

Br

F

CN

OH

Me

Et

i-Pr

c-Pr

CF₃

SMe

S(O)Me

S(O)₂Me

OMe

OEt

OCH₂OMe
 OCH₂CF₃
 C=CHMe
 C≡CMe
 NMe₂
 Ph
 PhO
 4-Me-Ph
 4-MeO-Ph
 H

G²=O, R⁹=Me, Y=CH,
 X=N
 R¹⁰

Cl
 Br
 F
 CN
 OH
 Me
 Et
i-Pr
c-Pr
 CF₃
 SMe
 S(O)Me
 S(O)₂Me
 OMe

OEt
 OCH₂OMe
 OCH₂CF₃
 C=CHMe
 C≡CMe
 NMe₂
 Ph
 PhO
 4-Me-Ph
 4-MeO-Ph
 H

G²=S

X	Y	R ¹⁴	R ⁹	R ¹³	R ¹⁰
N	CR ¹⁴	-(CH ₂) ₃ -		--	Me
CH	CR ¹⁴	-(CH ₂) ₃ -		--	Me
N	CR ¹⁴	-(CH ₂) ₄ -		--	Me
CH	CR ¹⁴	-(CH ₂) ₄ -		--	Me
CR ¹³	N	--	-(CH ₂) ₃ -		Me
CR ¹³	CH	--	-(CH ₂) ₃ -		Me
CR ¹³	N	--	-(CH ₂) ₄ -		Me
CR ¹³	CH	--	-(CH ₂) ₄ -		Me
CR ¹³	CH	--	Me	-(CH ₂) ₃ -	
CR ¹³	CH	--	Me	-(CH ₂) ₄ -	

G²=O

X	Y	R ¹⁴	R ⁹	R ¹³	R ¹⁰
N	CR ¹⁴	-(CH ₂) ₃ -		--	Me
CH	CR ¹⁴	-(CH ₂) ₃ -		--	Me
N	CR ¹⁴	-(CH ₂) ₄ -		--	Me
CH	CR ¹⁴	-(CH ₂) ₄ -		--	Me
CR ¹³	N	--	-(CH ₂) ₃ -		Me

CR ¹³	CH	--	-(CH ₂) ₃ -	Me
CR ¹³	N	--	-(CH ₂) ₄ -	Me
CR ¹³	CH	--	-(CH ₂) ₄ -	Me
CR ¹³	CH	--	Me	-(CH ₂) ₃ -
CR ¹³	CH	--	Me	-(CH ₂) ₄ -

TABLE 12

Compounds of Formula IId

G²=S, X=Y=N, R¹¹=R¹²=R²⁸=H

R ¹⁰	C-Pr	C-CHMe
Cl	CF ₃	C=CHMe
Br	SMe	NMe ₂
F	S(O)Me	Ph
CN	S(O) ₂ Me	PhO
OH	OMe	4-Me-Ph
Me	OEt	4-MeO-Ph
Et	OCH ₂ OMe	H
<i>i</i> -Pr	OCH ₂ CF ₃	

G²=S, R¹⁰=Me

X	Y	R ¹¹	R ¹²	R ²⁸	R ³¹
CH	N	H	H	H	H
N	CH	H	H	H	H
N	N	H	3-Me	4-Me	H
N	N	H	3-Me	4-Me	6-Me
N	N	Me	H	H	7-Me
N	N	H	H	4- <i>i</i> -Pr	6-OMe
N	N	H	3-Me	H	7-CF ₃
N	N	H	H	4-Et	7-Et
N	N	H	H	4- <i>i</i> -Pr	6-OCHF ₂
N	N	H	H	H	8-Bu
N	N	H	H	4- <i>c</i> -Pr	6-OEt

$G^2=O, X=Y=N, R^{11}=R^{12}=R^{28}=H$

R^{10}	c-Pr	OCH_2CF_3
Cl	CF_3	$C=CHMe$
Br	SMe	$C\equiv CMe$
F	S(O)Me	NMe_2
CN	S(O) ₂ Me	Ph
OH	OMe	PhO
Me	OEt	4-Me-Ph
Et	OCH_2OMe	4-MeO-Ph
i-Pr		H

 $G^2=O, R^{10}=Me$

X	Y	R^{11}	R^{12}	R^{28}	R^{31}
CH	N	H	H	H	H
N	CH	H	H	H	H
N	N	H	3-Me	4-Me	H
N	N	H	3-Me	4-Me	6-Me
N	N	Me	H	H	7-Me
N	N	H	H	4-i-Pr	6-OMe
N	N	H	3-Me	H	7- CF_3
N	N	H	H	4-Et	7-Et
N	N	H	H	4-i-Pr	6- $OCHF_2$
N	N	H	H	H	8-Bu
N	N	H	H	4-c-Pr	6-OEt

TABLE 13

Compounds of Formula IIe

$G^2=S, R^{12}=H, R^{28}=H$		$G^2=S, R^{11}=H, R^{28}=H$
R^{11}	Br	R^{12}
H	CF_3	3-Me
Me	OMe	3-Et
Et	OEt	3-i-Pr
i-Pr	$OCHF_2$	3-s-Bu
s-Bu	OBu	3-F
F	$O(CH_2)_3CF_3$	3-Cl
Cl	$(CH_2)_3CF_3$	3-Br

3-CF₃
 3-OMe
 3-OEt
 3-OCHF₂
 3-OBu
 3-O(CH₂)₃CF₃
 3-(CH₂)₃CF₃

 G²=S, R¹¹=R¹²=H
 R²⁸
 4-Me
 4-CN
 4-NO₂
 4-OH
 4-CO₂H
 4-CO₂Et
 4-Et
 4-*i*-Pr
 4-*n*-Hex
 4-*c*-Pr
 4-CF₃
 4-SMe
 4-SBu
 4-*c*-Hex
 4-Cl
 4-Br
 4-F
 4-(CH₂)₃CF₃
 4-S(O)Me
 4-S(O)Bu
 4-S(O)₂Me
 4-S(O)₂Bu
 4-OMe
 4-OBu
 4-OCH₂CF₃

4-OCH₂OMe
 4-CH₂OMe
 4-CH=CH-Me
 4-CH=CHCH₂Me
 4-TBS
 4-SiMe₃
 4-C≡CH
 4-C≡C-Et
 4-OCH₂C≡CH
 4-NMe₂
 4-C(=O)NMe₂
 4-Ph
 4-OPh
 4-SPh
 4-(3-Me-Ph)

 G²=S
 R¹¹ R¹² R²⁸
 Cl H 6-Cl
 H 3-Me 4-Me
 H 3-Me 4-Et
 H 3-OMe 4-OMe
 Me H 5-Me
 Me H 4-Me
 Me 4-Me 5-Me
 H 3-Cl 5-Cl
 Cl H 4-Cl

 G²=O, R¹²=H, R²⁸=H
 R¹¹
 H
 Me
 Et
i-Pr
s-Bu

F
 Cl
 Br
 CF₃
 OMe
 OEt
 OCHF₂
 OBu
 O(CH₂)₃CF₃
 (CH₂)₃CF₃

 G²=O, R¹¹=H, R²⁸=H
 R¹²
 3-Me
 3-Et
 3-*i*-Pr
 3-*s*-Bu
 3-F
 3-Cl
 3-Br
 3-CF₃
 3-OMe
 3-OEt
 3-OCHF₂
 3-OBu
 3-O(CH₂)₃CF₃
 3-(CH₂)₃CF₃
 4-Me

 G²=O, R¹¹=R¹²=H
 R²⁸
 4-CN
 4-NO₂
 4-OH
 4-CO₂H

4-CO ₂ Et	G ² =O	G ² =S(O), R ¹¹ =H,
4-Et	R ¹¹ R ¹² R ²⁸	R ²⁸ =H
4- <i>i</i> -Pr	Cl H 6-Cl	R ¹²
4- <i>n</i> -Hex	H 3-Me 4-Me	3-Me
4- <i>c</i> -Pr	H 3-Me 4-Et	3-Et
4-CF ₃	H 3-OMe 4-OMe	3- <i>i</i> -Pr
4-SMe	Me H 5-Me	3- <i>s</i> -Bu
4-SBu	Me H 4-Me	3-F
4- <i>c</i> -Hex	Me 4-Me 5-Me	3-Cl
4-Cl	H 3-Cl 5-Cl	3-Br
4-Br	Cl H 4-Cl	3-CF ₃
4-F		3-OMe
4-(CH ₂) ₃ CF ₃		3-OEt
4-S(O)Me	G ² =S(O), R ¹² =H,	3-OCHF ₂
4-S(O)Bu	R ²⁸ =H	3-OBu
4-S(O) ₂ Me	R ¹¹	3-O(CH ₂) ₃ CF ₃
4-S(O) ₂ Bu	H	3-(CH ₂) ₃ CF ₃
4-OMe	Me	
4-OBu	Et	G ² =S(O), R ¹¹ =R ¹² =H
4-OCH ₂ CF ₃	<i>i</i> -Pr	R ²⁸
4-OCH ₂ OMe	<i>s</i> -Bu	4-Me
4-CH ₂ OMe	F	4-CN
4-CH=CH-Me	Cl	4-NO ₂
4-CH=CHCH ₂ Me	Br	4-OH
4-TBS	CF ₃	4-CO ₂ H
4-SiMe ₃	OMe	4-CO ₂ Et
4-C≡CH	OEt	4-Et
4-C≡C-Et	OCHF ₂	4- <i>i</i> -Pr
4-OCH ₂ C≡CH	OBu	4- <i>n</i> -Hex
4-NMe ₂	O(CH ₂) ₃ CF ₃	4- <i>c</i> -Pr
4-C(=O)NMe ₂	(CH ₂) ₃ CF ₃	4-CF ₃
4-Ph		4-SMe
4-OPh		4-SBu
4-SPh		4- <i>c</i> -Hex
4-(3-Me-Ph)		4-Cl

4-Br
 4-F
 4-(CH₂)₃CF₃
 4-S(O)Me
 4-S(O)Bu
 4-S(O)₂Me
 4-S(O)₂Bu
 4-OMe
 4-OBu
 4-OCH₂CF₃
 4-OCH₂OMe
 4-CH₂OMe
 4-CH=CH-Me
 4-CH=CHCH₂Me
 4-TBS
 4-SiMe₃
 4-C≡CH
 4-C≡C-Et
 4-OCH₂C≡CH
 4-NMe₂
 4-C(=O)NMe₂
 4-Ph
 4-OPh
 4-SPh
 4-(3-Me-Ph)

 $G^2=S(O)$

R ¹¹	R ¹²	R ²⁸
Cl	H	6-Cl
H	3-Me	4-Me
H	3-Me	4-Et
H	3-OMe	4-OMe
Me	H	5-Me
Me	H	4-Me
Me	4-Me	5-Me

H	3-Cl	5-Cl
Cl	H	4-Cl

 $G^2=S(O)_2$, R¹²=H,
R²⁸=H
R¹¹

H

Me

Et

i-Pr*s*-Bu

F

Cl

Br

CF₃

OMe

OEt

OCHF₂

OBu

O(CH₂)₃CF₃(CH₂)₃CF₃
 $G^2=S(O)_2$, R¹¹=H,
R²⁸=H
R¹²

3-Me

3-Et

3-*i*-Pr3-*s*-Bu

3-F

3-Cl

3-Br

3-CF₃

3-OMe

3-OEt

3-OCHF₂

3-OBu

3-O(CH₂)₃CF₃3-(CH₂)₃CF₃ $G^2=S(O)_2$,R¹¹=R¹²=HR²⁸

4-Me

4-CN

4-NO₂

4-OH

4-CO₂H4-CO₂Et

4-Et

4-*i*-Pr4-*n*-Hex4-*c*-Pr4-CF₃

4-SMe

4-SBu

4-*c*-Hex

4-Cl

4-Br

4-F

4-(CH₂)₃CF₃

4-S(O)Me

4-S(O)Bu

4-S(O)₂Me4-S(O)₂Bu

4-OMe

4-OBu

4-OCH₂CF₃4-OCH₂OMe4-CH₂OMe

4-CH=CH-Me
 4-CH=CHCH₂Me
 4-TBS
 4-SiMe₃
 4-C≡CH
 4-C≡C-Et
 4-OCH₂C≡CH
 4-NMe₂
 4-C(=O)NMe₂
 4-Ph
 4-OPh
 4-SPh
 4-(3-Me-Ph)

G²=S(O)₂

R ¹¹	R ¹²	R ²⁸
Cl	H	6-Cl
H	3-Me	4-Me
H	3-Me	4-Et
H	3-OMe	4-OMe
Me	H	5-Me
Me	H	4-Me
Me	4-Me	5-Me
H	3-Cl	5-Cl
Cl	H	4-Cl

TABLE 14

Compounds of
 Formula IIf

n¹=1
 R²⁷
 H
 Et
 Bu
 i-Pr

CHF₂
 (CH₂)₃CF₃
 CO₂Et
 C(=O)Me
 C(=O)(CH₂)₃Me
 C(=O)Ph
 (3-Me-Ph)C(=O)
 (4-OMe-Ph)C(=O)
 CH₂C=CH₂
 CH₂C≡CH
 PhCH₂
 4-Me-PhCH₂
 S(O)₂Me
 C(=O)NMe₂
 C(=S)NHMe
 S(O)Me
 S(O)₂Ph
 (4-Me-Ph)S(O)₂
 C(=O)NHPh
 C(=S)NHPh
 P(=S)(OEt)₂
 P(=O)(OEt)₂
 S(O)₂N(Et)₂

n¹=2

R²⁷

H
 Et
 Bu
 i-Pr
 CHF₂
 (CH₂)₃CF₃
 CO₂Et
 C(=O)Me
 C(=O)(CH₂)₃Me

C(=O)Ph
 (3-Me-Ph)C(=O)
 (4-OMe-Ph)C(=O)
 CH₂C=CH₂
 CH₂C≡CH
 PhCH₂
 4-Me-PhCH₂
 S(O)₂Me
 C(=O)NMe₂
 C(=S)NHMe
 S(O)Me
 S(O)₂Ph
 (4-Me-Ph)S(O)₂
 C(=O)NHPh
 C(=S)NHPh
 P(=S)(OEt)₂
 P(=O)(OEt)₂
 S(O)₂N(Et)₂

n¹=3

R²⁷

H
 Et
 Bu
 i-Pr
 CHF₂
 (CH₂)₃CF₃
 CO₂Et
 C(=O)Me
 C(=O)(CH₂)₃Me
 C(=O)Ph
 (3-Me-Ph)C(=O)
 (3-Me-Ph)C(=O)
 CH₂C=CH₂
 CH₂C≡CH

PhCH ₂				1	1	S(O)
4-Me-PhCH ₂				1	2	S(O)
S(O) ₂ Me				2	1	S(O)
C(=O)NMe ₂				0	3	S(O)
C(=S)NHMe	n	n ¹	G ²	1	1	S(O) ₂
S(O)Me	1	1	S	1	2	S(O) ₂
S(O) ₂ Ph	1	2	S	2	1	S(O) ₂
(4-Me-Ph)S(O) ₂	2	1	S	0	3	S(O) ₂
C(=O)NHPh	0	3	S	1	1	N-Me
C(=S)NHPh	1	1	O	1	2	N-Me
P(=S)(OEt) ₂	1	2	O	2	1	N-Me
P(=O)(OEt) ₂	2	1	O			
S(O) ₂ N(Et) ₂	0	3	O			

TABLE 16

Compounds of Formula IIh

G²=S

n ²	R ¹	R ⁷	R ⁴	R ⁸
1	Me	H	H	H
1	Bu	H	H	H
1	Me	Me	H	H
1	H	H	Me	H
1	H	H	Bu	H
1	Ph	H	H	H
1	4-Me-Ph	H	H	H
1	4-OMe-Ph	H	H	H
0	Me	H	--	--
0	Bu	H	--	--
0	Me	Me	--	--
0	Ph	H	--	--
0	4-Me-Ph	H	--	--

G²=O

n ²	R ¹	R ⁷	R ⁴	R ⁸
1	Me	H	H	H
1	Bu	H	H	H

TABLE 15

Compounds of

Formula IIg

1	Me	Me	H	H
1	H	H	Me	H
1	H	H	Bu	H
1	Ph	H	H	H
1	4-Me-Ph	H	H	H
1	4-OMe-Ph	H	H	H
0	Me	H	--	--
0	Bu	H	--	--
0	Me	Me	--	--
0	Ph	H	--	--
0	4-Me-Ph	H	--	--

TABLE 17

Compounds of Formula IIi

G²=S

n ²	R ¹	R ²	R ³
0	Me	H	--
0	Bu	H	--
0	H	Me	--
0	H	Bu	--
0	Ph	H	--
0	4-Me-Ph	H	--

0	H	4-OMe-Ph	--	0	H	Me	--
n	R ¹	R ²	R ³	0	H	Bu	--
1	Me	H	H	0	Ph	H	--
1	Bu	H	H	0	4-Me-Ph	H	--
1	H	Me	H	0	H	4-OMe-Ph	--
1	H	Bu	H	1	Me	H	H
1	H	H	Me	1	Bu	H	H
1	H	H	Bu	1	H	Me	H
1	Ph	H	H	1	H	Bu	H
1	4-Me-Ph	H	H	1	H	H	Me
1	H	Ph	H	1	H	H	Bu
1	H	4-Me-Ph	H	1	Ph	H	H
1	H	H	Ph	1	4-Me-Ph	H	H
1	H	H	4-Me-Ph	1	H	Ph	H
				1	H	4-Me-Ph	H
				1	H	H	Ph
				1	H	H	4-Me-Ph
G ² =O							
n ²	R ¹	R ²	R ³				
0	Me	H	--				
0	Bu	H	--				

TABLE 18

Compounds of Formula IIj

G ² =S				H	H	H	4-OMe-Ph
R ¹	R ⁷	R ⁵	R ⁶	Bu	H	H	H
H	H	Me	H	3-Me-Ph	H	H	H
H	H	Ph	H	4-OMe-Ph	H	H	H
H	H	H	Me	G ² =O			
H	H	H	Ph	R ¹	R ⁷	R ⁵	R ⁶
Me	H	H	H	H	H	Me	H
Me	Me	H	H	H	H	Ph	H
Ph	H	H	H	H	H	H	Me
H	Ph	H	H	H	H	H	Ph
H	H	Bu	H	Me	H	H	H
H	H	4-Me-Ph	H	Me	Me	H	H
H	H	H	Bu	Ph	H	H	H

H	Ph	H	H
H	H	Bu	H
H	H	4-Me-Ph	H
H	H	H	Bu
H	H	H	4-OMe-Ph
Bu	H	H	H
3-Me-Ph	H	H	H
4-OMe-Ph	H	H	H

TABLE 19

Compounds of Formula IVc

G^2	n	n ¹
S	1	1
S	1	2
S	2	1
O	1	1
O	1	2
O	2	1
S(O)	1	1
S(O)	1	2
S(O)	2	1
S(O) ₂	1	1
S(O) ₂	1	2
S(O) ₂	2	1
NMe	1	1
NMe	1	2
NMe	2	1

TABLE 20

Compounds of Formula Im

 $G_2=S$, $MCl_x=ZnCl_2$

R^{11}	R^{12}	R^{28}
H	Me	H
H	Et	H
H	OMe	H

H	<i>i</i> -Pr	H
2-Cl	H	H
3-Cl	H	H
H	Cl	H
3-Me	Me	H
2-Me	H	5-Me
2-Cl	H	6-Cl

 $G_2=O$, $MCl_x=ZnCl_2$

R^{11}	R^{12}	R^{28}
H	Me	H
H	Et	H
H	OMe	H
H	<i>i</i> -Pr	H
2-Cl	H	H
3-Cl	H	H
H	Cl	H
3-Me	Me	H
2-Me	H	5-Me
2-Cl	H	6-Cl

 $G_2=S$, $MCl_x=FeCl_3$

R^{11}	R^{12}	R^{28}
H	Me	H
H	Et	H
H	OMe	H
H	<i>i</i> -Pr	H
2-Cl	H	H
3-Cl	H	H
H	Cl	H
3-Me	Me	H
2-Me	H	5-Me
2-Cl	H	6-Cl

$G_2=O$, $MCl_x=FeCl_3$

R^{11}	R^{12}	R^{28}
H	Me	H
H	Et	H
H	OMe	H
H	<i>i</i> -Pr	H
2-Cl	H	H
3-Cl	H	H
H	Cl	H
3-Me	Me	H
2-Me	H	5-Me
2-Cl	H	6-Cl

 $G_2=S$, $MCl_x=CuCl_2$

R^{11}	R^{12}	R^{28}
H	Me	H
H	Et	H
H	OMe	H
H	<i>i</i> -Pr	H
2-Cl	H	H
3-Cl	H	H
H	Cl	H
3-Me	Me	H
2-Me	H	5-Me
2-Cl	H	6-Cl

 $G_2=O$, $MCl_x=CuCl_2$

R^{11}	R^{12}	R^{28}
H	Me	H
H	Et	H
H	OMe	H
H	<i>i</i> -Pr	H
2-Cl	H	H
3-Cl	H	H
H	Cl	H

3-Me	Me	H
2-Me	H	5-Me
2-Cl	H	6-Cl

 $G_2=S$, $MCl_x=MnCl_2$

R^{11}	R^{12}	R^{28}
H	Me	H
H	Et	H
H	OMe	H
H	<i>i</i> -Pr	H
2-Cl	H	H
3-Cl	H	H
H	Cl	H
3-Me	Me	H
2-Me	H	5-Me
2-Cl	H	6-Cl

 $G_2=O$, $MCl_x=MnCl_2$

R^{11}	R^{12}	R^{28}
H	Me	H
H	Et	H
H	OMe	H
H	<i>i</i> -Pr	H
2-Cl	H	H
3-Cl	H	H
H	Cl	H
3-Me	Me	H
2-Me	H	5-Me
2-Cl	H	6-Cl

 $G_2=S$, $MCl_x=MgCl_2$

R^{11}	R^{12}	R^{28}
H	Me	H
H	Et	H
H	OMe	H

H	<i>i</i> -Pr	H	H	Et	H
2-Cl	H	H	H	OMe	H
3-Cl	H	H	H	<i>i</i> -Pr	H
H	Cl	H	2-Cl	H	H
3-Me	Me	H	3-Cl	H	H
2-Me	H	5-Me	H	Cl	H
2-Cl	H	6-Cl	3-Me	Me	H
			2-Me	H	5-Me
			2-Cl	H	6-Cl
$G_2=O, MCl_x=MgCl_2$					
R^{11}	R^{12}	R^{28}			
H	Me	H			

Formulation/Utility

Compounds of this invention will generally be used in formulation with an agriculturally suitable composition. The fungicidal compositions of the present invention comprise an effective amount of at least one compound of Formula I as defined above and at least one of (a) a surfactant, (b) an organic solvent, and (c) at least one solid or liquid diluent. Useful formulations can be prepared in conventional ways. They include dusts, granules, pellets, solutions, suspensions, emulsions, wettable powders, emulsifiable concentrates, dry flowables and the like. Sprayable formulations can be extended in suitable media and used at spray volumes from about one to several hundred liters per hectare. High strength compositions are primarily used as intermediates for further formulation. The formulations will typically contain effective amounts of active ingredient, diluent and surfactant within the following approximate ranges which add up 100 weight percent.

	Weight Percent		
	<u>Active Ingredient</u>	<u>Diluent</u>	<u>Surfactant</u>
Wettable Powders	25-90	0-74	1-10
Oil Suspensions, Emulsions, Solutions, (including Emulsifiable Concentrates)	5-50	40-95	0-15
Dusts	1-25	70-99	0-5
Granules, Baits and Pellets	0.01-99	5-99.99	0-15
High Strength Compositions	90-99	0-10	0-2

Typical solid diluents are described in Watkins, et al., *Handbook of Insecticide Dust Diluents and Carriers*, 2nd Ed., Dorland Books, Caldwell, New Jersey.

- 5 Typical liquid diluents and solvents are described in Marsden, *Solvents Guide*, 2nd Ed., Interscience, New York, 1950. McCutcheon's *Detergents and Emulsifiers Annual*, Allured Publ. Corp., Ridgewood, New Jersey, as well as Sisely and Wood, *Encyclopedia of Surface Active*
- 10 *Agents*, Chemical Publ. Co., Inc., New York, 1964, list surfactants and recommended uses. All formulations can contain minor amounts of additives to reduce foam, caking, corrosion, microbiological growth, etc.

- Methods for formulating such compositions are well
- 15 known. Solutions are prepared by simply mixing the ingredients. Fine solid compositions are made by blending and, usually, grinding as in a hammer mill or fluid energy mill. Water-dispersible granules can be produced by agglomerating a fine powder composition;
- 20 see for example, Cross et al., *Pesticide Formulations*, Washington, D.C., 1988, pp 251-259. Suspensions are prepared by wet-milling; see, for example, U.S. 3,060,084. Granules and pellets can be made by

spraying the active material upon preformed granular carriers or by agglomeration techniques. See Browning, "Agglomeration", *Chemical Engineering*, December 4, 1967, pp 147-148, *Perry's Chemical Engineer's Handbook*, 4th Ed., McGraw-Hill, New York, 1963, pp 8-57 and following, and WO 91/13546. Pellets can be prepared as described in U.S. 4,172,714. Water-dispersible and water-soluble granules can be prepared as taught in DE 3,246,493.

10 For further information regarding the art of formulation, see U.S. 3,235,361, Col. 6, line 16 through Col. 7, line 19 and Examples 10 through 41; U.S. 3,309,192, Col. 5, line 43 through Col. 7, line 62 and Examples 8, 12, 15, 39, 41, 52, 53, 58, 132, 15 138-140, 162-164, 166, 167 and 169-182; U.S. 2,891,855, Col. 3, line 66 through Col. 5, line 17 and Examples 1-4; Klingman, *Weed Control as a Science*, John Wiley and Sons, Inc., New York, 1961, pp 81-96; and Hance et al., *Weed Control Handbook*, 8th Ed., Blackwell 20 Scientific Publications, Oxford, 1989.

In the following Examples, all percentages are by weight and all formulations are worked up in conventional ways. Compound numbers refer to Index Table A hereinafter.

25 Example A

Wettable Powder

Compound 11	65.0%
dodecylphenol polyethylene glycol ether	2.0%
sodium ligninsulfonate	4.0%
30 sodium silicoaluminate	6.0%
montmorillonite (calcined)	23.0%.

Example B

Granule

Compound 11	10.0%
35 attapulgite granules (low volative	

matter, 0.71/0.30 mm; U.S.S. No.
25-50 sieves)

90.0%.

Example CExtruded Pellet

5	Compound 11	25.0%
	anhydrous sodium sulfate	10.0%
	crude calcium ligninsulfonate	5.0%
	sodium alkyl naphthalenesulfonate	1.0%
	calcium/magnesium bentonite	59.0%.

10

Example DEmulsifiable Concentrate

	Compound 11	20.0%
	blend of oil soluble sulfonates and polyoxyethylene ethers	10.0%
15	isophorone	70.0%.

The compounds of this invention are useful as plant disease control agents. The present invention therefore further comprises a method for controlling plant diseases caused by fungal plant pathogens comprising applying to the plant or portion thereof to be protected, or to the plant seed or seedling to be protected, an effective amount of a compound of Formula I or a fungicidal composition containing said compound. The compounds and compositions of this invention provide control of diseases caused by a broad spectrum of fungal plant pathogens in the *Basidiomycete*, *Ascomycete*, *Oomycete* and *Deuteromycete* classes. They are effective in controlling a broad spectrum of plant diseases, particularly foliar pathogens of ornamental, vegetable, field, cereal, and fruit crops. These pathogens include *Plasmopara viticola*, *Phytophthora infestans*, *Peronospora tabacina*, *Pseudoperonospora cubensis*, *Pythium aphanidermatum*, *Alternaria brassicae*, *Septoria nodorum*, *Cercosporidium personatum*, *Cercospora arachidicola*, *Pseudocercospora herpotrichoides*,

Cercospora beticola, *Botrytis cinerea*, *Monilinia fructicola*, *Pyricularia oryzae*, *Podosphaera leucotricha*, *Venturia inaequalis*, *Erysiphe graminis*, *Uncinula necatur*, *Puccinia recondita*, *Puccinia*
5 *graminis*, *Hemileia vastatrix*, *Puccinia striiformis*,
Puccinia arachidis, *Rhizoctonia solani*, *Sphaerotheca fuliginea*, *Fusarium oxysporum*, *Verticillium dahliae*,
Pythium aphanidermatum, *Phytophthora megasperma* and
other genera and species closely related to these
10 pathogens.

Compounds of this invention can also be mixed with one or more other insecticides, fungicides, nematocides, bactericides, acaricides, semiochemicals, repellants, attractants, pheromones, feeding stimulants
15 or other biologically active compounds to form a multi-component pesticide giving an even broader spectrum of agricultural protection. Examples of other agricultural protectants with which compounds of this invention can be formulated are: insecticides such as
20 monocrotophos, carbofuran, tetrachlorvinphos, malathion, parathion-methyl, methomyl, chlordimeform, diazinon, deltamethrin, oxamyl, fenvalerate, esfenvalerate, permethrin, profenofos, sulprofos, triflumuron, diflubenzuron, methoprene, buprofezin,
25 thiodicarb, acephate, azinphosmethyl, chlorpyrifos, dimethoate, fipronil, flufenprox, fonophos, isofenphos, methidathion, methamidophos, phosmet, phosphamidon, phosalone, pirimicarb, phorate, terbufos, trichlorfon, methoxychlor, bifenthrin, biphenate, cyfluthrin,
30 fenpropathrin, fluvalinate, flucythrinate, tralomethrin, metaldehyde and rotenone; fungicides such as carbendazim, thiuram, dodine, maneb, chloroneb, benomyl, cymoxanil, fenpropidine, fenpropimorph, triadimefon, captan, thiophanate-methyl, thiabendazole,
35 phosethyl-Al, chlorothalonil, dichloran, metalaxyl,

captafol, iprodione, oxadixyl, vinclozolin,
kasugamycin, myclobutanil, tebuconazole,
difenoconazole, diniconazole, fluquinconazole,
ipconazole, metconazole, penconazole, propiconazole,
5 uniconazole, flutriafol, prochloraz, pyrifenox,
fenarimol, triadimenol, diclobutrazol, copper
oxychloride, furalaxyl, folpet, flusilazol,
blastidicin S, diclomezine, edifenphos, isoprothiolane,
iprobenfos, mepronil, neo-asozin, pencycuron,
10 probenazole, pyroquilon, tricyclazole, validamycin, and
flutolanil; nematocides such as aldoxycarb, fenamiphos
and fosthietan; bactericides such as oxytetracycline,
streptomycin and tribasic copper sulfate; acaricides
such as binapacryl, oxythioquinox, chlorobenzilate,
15 dicofol, dienochlor, cyhexatin, hexythiazox, amitraz,
propargite, tebufenpyrad and fenbutatin oxide; and
biological agents such as *Bacillus thuringiensis*,
baculovirus and avermectin B.

In certain instances, combinations with other
20 fungicides having a similar spectrum of control but a
different mode of action will be particularly
advantageous for resistance management.

Plant disease control is ordinarily accomplished by
applying an effective amount of a compound of this
25 invention either pre- or post-infection, to the portion
of the plant to be protected such as the roots, stems,
foliage, fruit, seeds, tubers or bulbs, or to the media
(soil or sand) in which the plants to be protected are
growing. The compounds can also be applied to the seed
30 to protect the seed and seedling.

Rates of application for these compounds can be
influenced by many factors of the environment and
should be determined under actual use conditions.
Foliage can normally be protected when treated at a
35 rate of from less than 1 g/ha to 5,000 g/ha of active

ingredient. Seed and seedlings can normally be protected when seed is treated at a rate of from 0.1 to 10 g per kilogram of seed.

The following Tests demonstrate the control efficacy of compounds of this invention on specific pathogens. The pathogen control protection afforded by the compounds is not limited, however, to these species. See Index Table A for compound descriptions.

Test compounds were first dissolved in acetone in an amount equal to 3% of the final volume and then suspended at a concentration of 200 ppm in purified water containing 250 ppm of the surfactant Trem® 014 (polyhydric alcohol esters). The resulting test suspensions were then used in the following tests.

15

TEST A

The test suspension was sprayed to the point of run-off on wheat seedlings. The following day the seedlings were inoculated with a spore dust of *Erysiphe graminis f. sp. tritici*, (the causal agent of wheat powdery mildew) and incubated in a growth chamber at 20°C for 7 days, after which disease ratings were made.

20

TEST B

The test suspension was sprayed to the point of run-off on wheat seedlings. The following day the seedlings were inoculated with a spore suspension of *Puccinia recondita* (the causal agent of wheat leaf rust) and incubated in a saturated atmosphere at 20°C for 24 h, and then moved to a growth chamber at 20°C for 6 days, after which disease ratings were made.

25

30

TEST C

The test suspension was sprayed to the point of run-off on rice seedlings. The following day the seedlings were inoculated with a spore suspension of *Pyricularia oryzae* (the causal agent of rice blast) and incubated in a saturated atmosphere at 27°C for 24 h,

35

and then moved to a growth chamber at 30°C for 5 days, after which disease ratings were made.

TEST D

The test suspension was sprayed to the point of run-off on tomato seedlings. The following day the seedlings were inoculated with a spore suspension of *Phytophthora infestans* (the causal agent of potato and tomato late blight) and incubated in a saturated atmosphere at 20°C for 24 h, and then moved to a growth chamber at 20°C for 5 days, after which disease ratings were made.

TEST E

The test suspension was sprayed to the point of run-off on grape seedlings. The following day the seedlings were inoculated with a spore suspension of *Plasmopara viticola* (the causal agent of grape downy mildew) and incubated in a saturated atmosphere at 20°C for 24 h, moved to a growth chamber at 20°C for 6 days, and then incubated in a saturated atmosphere at 20°C for 24 h, after which disease ratings were made.

TEST F

The test suspension was sprayed to the point of run-off on cucumber seedlings. The following day the seedlings were inoculated with a spore suspension of *Botrytis cinerea* (the causal agent of gray mold on many crops) and incubated in a saturated atmosphere at 20°C for 48 h, and moved to a growth chamber at 20°C for 5 days, after which disease ratings were made.

30

Index Table 1

Compounds of Formula I

R⁹=R¹⁰=Me; X=CH; Y=N

Cmpd. No.	G ¹ -G ² -G ³	E	mp (°C)
1	CH ₂ OCH ₂	Ph	a
2	CH ₂ CH ₂ S	4-Cl-Ph	a

3	CH ₂ OCH ₂	4-Et-Ph	a
4	CH ₂ CH ₂ O	3-Me-Ph	a
5	CH ₂ CH ₂ S	3-Me-Ph	a
6	CH ₂ CH ₂ O	2,6-diCl-Ph	a
7	CH ₂ CH ₂ S	4-Me-Ph	a
8	CH ₂ CH ₂ S	2-Cl-Ph	146-148
9	CH ₂ CH ₂ S	3-Cl-Ph	a
10	CH ₂ CH ₂ O	4-Et-Ph	99-106
11	CH ₂ CH ₂ S	4-Et-Ph	84-87
12	CH ₂ CH ₂ SO	2-Cl-Ph	168-170
13	CH ₂ CH ₂ S	Ph	142-145
14	CH ₂ CH ₂ S	3-CF ₃ -Ph	105-110
15	CH ₂ CH ₂ S	4-OMe-Ph	111-115
16	CH ₂ CH ₂ SO	4-Et-Ph	149-164
17	CH ₂ CH ₂ SO ₂	4-Et-Ph	139-141
18	CH ₂ CH ₂ S	4-t-Bu	114-121
19	CH ₂ CH ₂ CH ₂ S	4-OMe-Ph	119-123
20	CH ₂ CH ₂ S	OPh	75-85
21	CH ₂ CH ₂ CH ₂ S	4-Et-Ph	97-100
22	CH(CH ₃)CH ₂ S	4-Et-Ph	a
23	CH ₂ CH ₂ S	2-Me-Ph	86-91
24	CH ₂ CH ₂ S	OBzl	81-93
25	CH ₂ CH ₂ S	SPh	a
26	CH ₂ CH ₂ S	Bzl	a
27	CH ₂ CH ₂ CH ₂ S	Ph	158-160
28	CH(CH ₃)CH ₂ S	Ph	a
29	CH ₂ C(CH ₃) ₂ CH ₂ S	Ph	116-121
30	CH ₂ CH(Ph)S	Ph	196-208
31	CH ₂ CH ₂ S	Et	a
32	CH ₂ CH(CO ₂ Et)S	Ph	124-133
33	CH ₂ CH(Ph)SO ₂	Ph	201-206
34	CH(CF ₃)CH ₂ S	Ph	174-181
35	CH(CH ₂ CH ₃)CH ₂ S	Ph	a
36	CH ₂ CH(CN)S	Ph	208-212
37	CH(CN)CH ₂ S	Ph	168-174

38	CH ₂ CH ₂ S	3,4-diCl-Ph	149-152
39	CH ₂ CH ₂ S	4-Ph-Ph	151-155
40	CH ₂ CH ₂ S	3,4-diOMe-Ph	172-174

^a Oil or gum; ¹H NMR data in Index Table 2.

X=CR¹³; R⁹ and R¹³ are taken together to form a fused benzene ring; Y=N; R¹⁰=Me

Cmpd. No.	G ¹ -G ² -G ³	E	mp (°C)
38	CH ₂ CH ₂ S	Ph	102-108

5

R⁹=R¹⁰=ethyl; X=CH; Y=N

Cmpd. No.	G ¹ -G ² -G ³	E	mp (°C)
39	CH ₂ CH ₂ S	Ph	oil; ¹ H NMR data in Index Table 2.

Index Table 2

Cmpd. No.	¹ H NMR Data ^a
1	7.75 (m, 2H), 7.37 (m, 3H), 6.57 (s, 1H), 5.54 (s, 2H), 4.83 (s, 2H), 2.42 (s, 6H).
2	7.83 (d, 2H), 7.35 (d, 2H), 6.56 (s, 1H), 4.47 (t, 2H), 3.36 (t, 2H), 2.43 (s, 6H).
3	7.66 (d, 2H), 7.21 (d, 2H), 6.56 (s, 1H), 5.54 (s, 2H), 4.81 (s, 2H), 2.67 (q, 2H), 2.42 (s, 6H), 1.24 (t, 3H).
4	7.82 (m, 1H), 7.75 (m, 1H), 7.25 (m, 1H), 7.19 (m, 1H), 6.49 (s, 1H), 4.54 (m, 2H), 4.28 (m, 2H), 2.42 (s, 6H), 2.38 (s, 3H).
5	7.7 (m, 2H), 7.2 (m, 2H), 6.54 (s, 1H), 4.45 (m, 2H), 3.35 (m, 2H), 2.42 (s, 6H), 2.39 (s, 3H).
6	7.31 (m, 2H), 7.25 (m, 1H), 6.5 (s, 1H), 4.55 (m, 2H), 4.35 (m, 2H), 2.38 (s, 6H).

7	7.77 (d, 2H), 7.18 (d, 2H), 6.53 (s, 1H), 4.46 (m, 2H), 3.35 (m, 2H), 2.42 (s, 6H), 2.37 (s, 3H).
9	7.90 (m, 1H), 7.75 (m, 1H), 7.3 (m, 2H), 6.57 (s, 1H), 4.47 (m, 2H), 3.36 (m, 2H), 2.43 (s, 6H).
22	7.82 (d, 2H), 7.22 (d, 2H), 6.52 (s, 1H), 5.7 (m, 1H), 3.45 (d, 1H), 3.00 (d, 1H), 2.7 (q, 2H), 2.42 (s, 6H), 1.38 (d, 3H), 1.24 (t, 3H).
25	7.65 (m, 2H), 7.34 (m, 3H), 6.55 (s, 1H), 4.40 (m, 2H), 3.25 (m, 2H), 2.41 (s, 6H).
26	7.37 (d, 2H), 7.32 (t, 2H), 7.25 (d, 1H), 6.51 (s, 1H), 4.32 (m, 2H), 3.89 (s, 2H), 3.19 (m, 2H), 2.41 (s, 6H).
28	7.93 (d, 2H), 7.37 (m, 3H), 6.54 (s, 1H), 5.7 (m, 1H), 3.45 (d, 1H), 3.02 (m, 1H), 2.42 (s, 6H), 1.40 (d, 3H).
31	6.48 (s, 1H), 4.33 (t, 2H), 3.25 (t, 2H), 2.58 (q, 2H), 2.39 (s, 6H), 1.26 (t, 3H).
35	7.85 (d, 2H), 7.37 (m, 3H), 6.52 (s, 1H), 5.50 (m, 1H), 3.38 (d, 1H), 3.20 (d, 1H), 2.41 (s, 6H), 1.80 (m, 2H), 0.99 (t, 3H).
39	7.85 (d, 2H), 7.37 (m, 3H), 6.56 (s, 1H), 4.45 (m, 2H), 3.35 (m, 2H), 2.72 (q, 4H), 1.31 (t, 6H).

^a ¹H NMR data are in ppm downfield from tetramethylsilane. Coupling are designated (s)-singlet, (d)-doublet, (t)-triplet, (q)-quartet, (m)-multiplet. Samples were dissolved in CDCl₃.

- 5 Results for Tests A-F are given in Table A. In the table, a rating of 100 indicates 100% disease control and a rating of 0 indicates no disease control (relative to the controls). NT = Not Tested.

Table A

Cmpd No.	Test A	Test B	Test C	Test D	Test E	Test F
1	98	100	65	23	75	65
2	76	93	99	11	91	2
3	86*	84*	72*	59*	44	77
4	73*	64*	73*	36*	0*	32*
5	24*	64*	73*	10*	0*	32*
6	0*	0*	29*	0*	86*	46*
8	0	80	85	3	100	98
9	98	100	99	82	92	98
10	94	100	99	52	85	82
11	99	100	97	52	92	98
12	56	0	0	60	92	0
13	98	96	91	91	100	77
14	98	82	100	73	100	47
15	96	98	97	0	100	98
16	82	0	0	0	13	0
17	61	14	0	NT	14	0
18	82	0	86	0	73	83
19	29	21	57	18	96	99
20	90	98	99	85	99	99
21	98	98	94	0	100	69
22	0	55	91	58	100	0
23	74	100	94	73	100	80
24	83	91	32	63	84	0
25	90	100	91	63	100	70
26	92	98	85	70	100	46
27	55	23	91	14	74	98
28	56*	96	91	0	100	94
29	52	80	74	22*	92	94
30	0	55	0	22	99	66
31	89	55	0	44	0	66
32	0	0	0	0	99	82
33	0*	54*	0*	0*	9*	34*
34	0*	54*	0*	0*	0*	0*

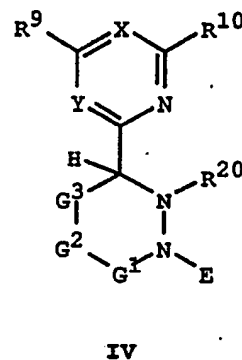
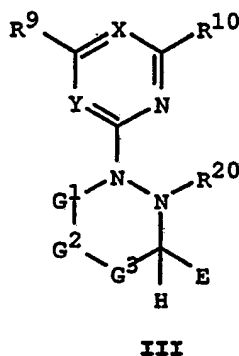
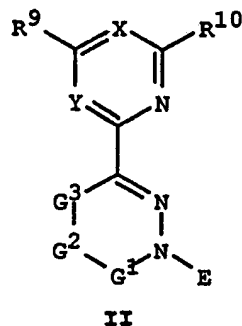
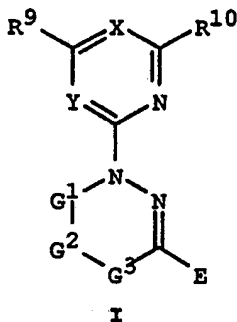
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38	29	93	97	23	96	0
39	98	83	91	0	100	90

*=Applications of the compound was made at a rate of 40 ppm.

What is claimed is:

1. The compounds of Formulae I, II, III and IV,



wherein:

- 10 -G¹-G²-G³- taken together with the attached atoms
 form a 5-8 membered ring, wherein
 -G¹- is -CR¹R⁷-; -(CHR¹CHR²)-; -(CHR¹CHR²CHR³)-; or
 -(CHR¹CHR²CHR³CHR⁴)-;
 -G²-is -O-; -S-; -S(O)-; -S(O)₂- or -NR²⁷-;
 15 -G³-is -CR⁴R⁸-; -(CHR⁵CHR⁶)-; -(CHR³CHR⁵CHR⁶)- or a
 direct bond;
 X is N or CR¹³;
 Y is N or CR¹⁴;
 E is H; C₁-C₆ alkyl; C₃-C₇ cycloalkyl optionally
 20 substituted with 1-2 methyl; C₁-C₆ haloalkyl;
 C₁-C₆ alkylthio; C₁-C₆ alkoxy; C₁-C₆ haloalkoxy;
 or phenyl, phenoxy, phenylthio, phenylamino,

phenylmethyl, indanyl, tetrahydronaphthalenyl, 1-naphthalenyl, 2-naphthalenyl, thienyl, furanyl or pyridyl each optionally substituted with R¹¹, R¹² and R²⁸;

- 5 R¹, R², R³, R⁴, R⁵, R⁶, R⁷ and R⁸ are each independently H; C₁-C₄ alkyl; C₁-C₄ haloalkyl, halogen, CO₂CH₃, CO₂CH₂CH₃, cyano or phenyl optionally substituted with R²⁵;

provided that

- 10 (i) the maximum number of carbon atoms in -G¹-G²-G³- with geminal disubstitution is one;
- (ii) the maximum number of optionally substituted phenyl substituents on
- 15 -G¹-G²-G³- is one;
- (iii) -G³- is other than a direct bond in compounds of Formulae III and IV; and
- (iv) -G²-G³- is other than -NR²⁷- in compounds of Formulae I and II;

- 20 R⁹, R¹⁰ and R¹³ are each independently H; halogen; cyano; hydroxy; C₁-C₆ alkyl; C₁-C₄ haloalkyl; C₁-C₄ alkylthio; C₁-C₄ alkylsulfinyl; C₁-C₄ alkylsulfonyl; C₃-C₆ cycloalkyl optionally substituted with 1-2 methyl groups; C₁-C₄
- 25 alkoxy; C₁-C₄ haloalkoxy; C₂-C₄ alkoxyalkyl; C₂-C₄ alkenyl; C₂-C₄ haloalkenyl; C₂-C₄ alkenyloxy; C₂-C₄ alkynyl; C₂-C₄ alkynyloxy; NR²⁹R³⁰; or phenyl or phenoxy optionally substituted with R³¹; or

- 30 R⁹ and R¹³, or R¹⁰ and R¹³, or R⁹ and R¹⁴ can be taken together to form -(CH₂)₃-, -(CH₂)₄- or a fused benzene ring optionally substituted with R³¹;

R¹¹, R¹², R²¹, R²⁴, R²⁶ and R³¹ are each independently halogen; C₁-C₄ alkyl; C₁-C₄ haloalkyl; C₁-C₄ alkoxy; or C₁-C₄ haloalkoxy; R¹⁴ is H; halogen; C₁-C₂ alkyl; or C₁-C₂ alkoxy;

5 R¹⁵, R¹⁶, R¹⁷, R¹⁸, R²⁹ and R³⁰ are each independently H or C₁-C₂ alkyl; or R¹⁵ and R¹⁶, or R¹⁷ and R¹⁸, or R²⁹ and R³⁰ can be taken together along with the nitrogen atom to which they are attached to form a

10 4-morpholinyl, pyrrolidinyl or piperidinyl ring;

R²⁰ and R²⁷ are each independently H; C₁-C₄ alkyl; C₁-C₄ haloalkyl; C₂-C₅ alkylcarbonyl; phenylcarbonyl optionally substituted with R²¹; C₃-C₄ alkenyl; C₃-C₄ alkynyl; phenylmethyl optionally substituted with R²¹ on the phenyl ring; C₁-C₄ alkylsulfinyl; C₁-C₄ alkylsulfonyl; phenylsulfinyl, phenylsulfonyl or phenoxycarbonyl each optionally substituted with R²¹; C₂-C₄ alkoxy carbonyl; C(=O)NR²²R²³; C(=S)NHR²³;

15 P(=S)(C₁-C₄ alkoxy)₂; P(=O)(C₁-C₄ alkoxy)₂; or S(=O)₂NR²²R²³;

R²² is H or C₁-C₃ alkyl;

R²³ is C₁-C₄ alkyl; or phenyl optionally substituted with R²⁴; or

25 R²² and R²³ can be taken together along with the nitrogen atom to which they are attached to form a 4-morpholinyl, pyrrolidinyl, piperidinyl or imidazolyl ring;

30 R²⁵ is 1-2 halogen; C₁-C₄ alkyl; C₁-C₄ haloalkyl; C₁-C₄ alkoxy; C₁-C₄ haloalkoxy; nitro; cyano or C₁-C₄ alkylthio; and

R²⁸ is halogen; cyano; nitro; hydroxy; hydroxycarbonyl; C₁-C₆ alkyl; C₃-C₆ cycloalkyl; C₁-C₆ haloalkyl; C₁-C₄ alkylthio; C₁-C₄ alkyl-

35

sulfinyl; C₁-C₄ alkylsulfonyl; (C₁-C₄ alkyl)₃silyl; C₂-C₅ alkylcarbonyl; C₂-C₄ alkenyl; C₃-C₄ alkenyloxy; C₂-C₄ alkynyl; C₃-C₄ alkynyloxy; C₁-C₄ alkoxy; C₁-C₄ haloalkoxy; C₂-C₄ alkoxyalkyl; C₂-C₅ alkoxy carbonyl; C₂-C₄ alkoxyalkoxy; NR¹⁵R¹⁶; C(=O)NR¹⁷R¹⁸; or phenyl, phenoxy or phenylthio each optionally substituted with R²⁶;

provided that

when E is, C₁-C₆ alkylthio, C₁-C₆ alkoxy, C₁-C₆ haloalkoxy, phenoxy, phenylthio or phenylamino, then E may only substitute compounds of Formula I.

and agriculturally suitable salts and metal complexes thereof.

2. The compounds of Claim 1, Formula I, wherein:

Y is N;

E is phenyl, indanyl, tetrahydronaphthalenyl, 1-naphthalenyl, thienyl, or pyridyl each optionally substituted with R¹¹, R¹² and R²⁸;

R¹, R², R³, R⁴, R⁵, R⁶, R⁷ and R⁸ are each independently H or methyl;

R¹¹ and R¹² are each independently F, Cl, methyl, trifluoromethyl, methoxy or trifluoromethoxy;

R¹³ is H;

R⁹ and R¹⁰ are each independently halogen; C₁-C₄ alkyl; cyclopropyl; C₁-C₄ haloalkyl; allyl; or C₂-C₃ alkynyl; or

R⁹ and R¹³ can be taken together to form a fused benzene ring optionally substituted with R³¹;

R²⁸ is halogen; cyano; C₁-C₄ alkyl; C₁-C₄ haloalkyl; allyl; propargyl; C₁-C₄ alkoxy;

C₁-C₄ haloalkoxy; or phenyl or phenoxy each optionally substituted with R²⁶; and

R³¹ is halogen; C₁-C₄ alkyl or C₁-C₄ haloalkyl.

3. The compounds of Claim 2, wherein:

5 G² is O; S or NR²⁷; and

E is phenyl optionally substituted with R¹¹, R¹² and R²⁸; indanyl or tetrahydronaphthalenyl.

4. The compounds of Claim 3, wherein:

G² is O; S; NH or N(C₁-C₄ alkyl); and

10 E is phenyl optionally substituted with R¹¹, R¹² and R²⁸.

5. The compound of Claim 1, which is

3-(4,6-dimethyl-2-pyrimidinyl)-3,6-dihydro-5-phenyl-2H-1,3,4-oxadiazine.

15 6. The compound of Claim 1, which is

3-(4,6-dimethyl-2-pyrimidinyl)-5-(4-ethyl-phenyl)-3,6-dihydro-2H-1,3,4-oxadiazine.

7. The compound of Claim 1, which is

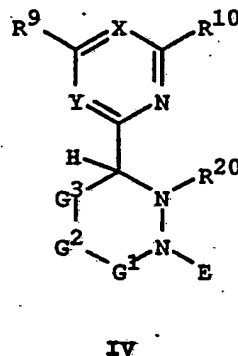
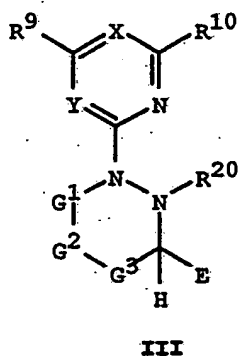
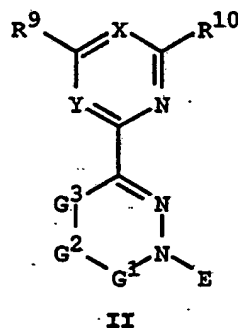
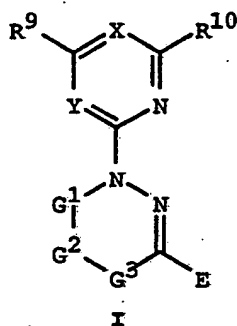
20 2-(2-chlorophenyl)-4-(4,6-dimethyl-2-pyrimidinyl)-5,6-dihydro-4H-1,3,4-thiadiazine.

8. The compound of Claim 1, which is

4-(4,6-dimethyl-2-pyrimidinyl)-2-(4-ethyl-phenyl)-5,6-dihydro-4H-1,3,4-thiadiazine.

25 9. A method of controlling fungus disease in plants which comprises treating the locus to be protected with an effective amount of at least one of the compounds of Formulae I, II, III or IV, agriculturally suitable salts thereof, agriculturally suitable metal complexes thereof, or agricultural compositions containing them;

30



5 wherein:

-G¹-G²-G³- taken together with the attached atoms form a 5-8 membered ring, wherein

-G¹- is -CR¹R⁷-; -(CHR¹CHR²)-; -(CHR¹CHR²CHR³)-; or -(CHR¹CHR²CHR³CHR⁴)-;

10 -G²- is -O-; -S-; -S(O)-; -S(O)₂- or -NR²⁷-;

-G³- is -CR⁴R⁸-; -(CHR⁵CHR⁶)-; -(CHR³CHR⁵CHR⁶)- or a direct bond;

X is N or CR¹³;

Y is N or CR¹⁴;

15 E is H; C₁-C₆ alkyl; C₃-C₇ cycloalkyl optionally substituted with 1-2 methyl; C₁-C₆ haloalkyl; C₁-C₆ alkylthio; C₁-C₆ alkoxy; C₁-C₆ haloalkoxy; or phenyl, phenoxy, phenylthio, phenylamino, phenylmethyl, indanyl, tetrahydronaphthalenyl, 1-naphthalenyl, 2-naphthalenyl, thienyl, furanyl or pyridyl each optionally substituted with R¹¹, R¹² and R²⁸;

20

R^1 , R^2 , R^3 , R^4 , R^5 , R^6 , R^7 and R^8 are each independently H; C_1 - C_4 alkyl; C_1 - C_4 haloalkyl, halogen, CO_2CH_3 , $CO_2CH_2CH_3$, cyano, or phenyl optionally substituted with R^{25} ;

5 provided that

(i) the maximum number of carbon atoms in $-G^1-G^2-G^3-$ with geminal disubstitution is one;

(ii) the maximum number of optionally substituted phenyl substituents on $-G^1-G^2-G^3-$ is one;

(iii) $-G^3-$ is other than a direct bond in compounds of Formulae III and IV; and

(iv) $-G^2-G^3-$ is other than $-NR^{27}-$ in compounds of Formulae I and II;

R^9 , R^{10} and R^{13} are each independently H; halogen; cyano; hydroxy; C_1 - C_6 alkyl; C_1 - C_4 haloalkyl; C_1 - C_4 alkylthio; C_1 - C_4 alkylsulfinyl; C_1 - C_4 alkylsulfonyl; C_3 - C_6 cycloalkyl optionally substituted with 1-2 methyl groups; C_1 - C_4 alkoxy; C_1 - C_4 haloalkoxy; C_2 - C_4 alkoxyalkyl; C_2 - C_4 alkenyl; C_2 - C_4 haloalkenyl; C_2 - C_4 alkenyloxy; C_2 - C_4 alkynyl; C_2 - C_4 alkynyloxy; $NR^{29}R^{30}$; or phenyl or phenoxy optionally substituted with R^{31} ; or

R^9 and R^{13} , or R^{10} and R^{13} , or R^9 and R^{14} can be taken together to form $-(CH_2)_3-$, $-(CH_2)_4-$ or a fused benzene ring optionally substituted with R^{31} ;

R^{11} , R^{12} , R^{21} , R^{24} , R^{26} and R^{31} are each independently halogen; C_1 - C_4 alkyl; C_1 - C_4 haloalkyl; C_1 - C_4 alkoxy; or C_1 - C_4 haloalkoxy; R^{14} is H; halogen; C_1 - C_2 alkyl; or C_1 - C_2 alkoxy; R^{15} , R^{16} , R^{17} , R^{18} , R^{29} and R^{30} are each independently H or C_1 - C_2 alkyl; or

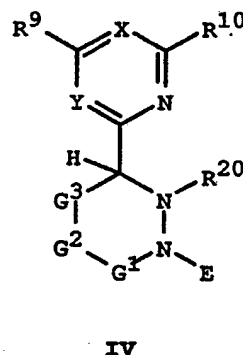
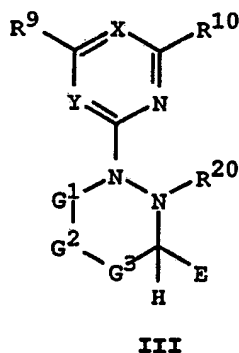
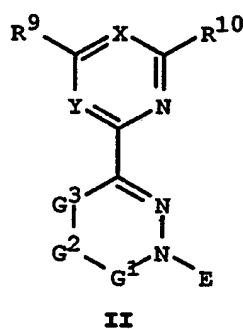
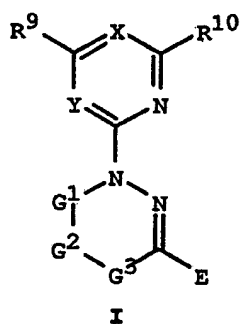
- R^{15} and R^{16} , or R^{17} and R^{18} , or R^{29} and R^{30} can be taken together along with the nitrogen atom to which they are attached to form a 4-morpholinyl, pyrrolidinyl or piperidinyl ring;
- 5 R^{20} and R^{27} are each independently H; C_1-C_4 alkyl; C_1-C_4 haloalkyl; C_2-C_5 alkylcarbonyl; phenylcarbonyl optionally substituted with R^{21} ; C_3-C_4 alkenyl; C_3-C_4 alkynyl; phenylmethyl optionally substituted with R^{21} on the phenyl ring; C_1-C_4 alkylsulfinyl; C_1-C_4 alkylsulfonyl; phenylsulfinyl, phenylsulfonyl or phenoxy carbonyl each optionally substituted with R^{21} ; C_2-C_4 alkoxy carbonyl; $C(=O)NR^{22}R^{23}$; $C(=S)NHR^{23}$;
- 10 $P(=S)(C_1-C_4 \text{ alkoxy})_2$; $P(=O)(C_1-C_4 \text{ alkoxy})_2$; or
- 15 $S(=O)_2NR^{22}R^{23}$;
- R^{22} is H or C_1-C_3 alkyl;
- R^{23} is C_1-C_4 alkyl; or phenyl optionally substituted with R^{24} ; or
- 20 R^{22} and R^{23} can be taken together along with the nitrogen atom to which they are attached to form a 4-morpholinyl, pyrrolidinyl, piperidinyl or imidazolyl ring;
- R^{25} is 1-2 halogen; C_1-C_4 alkyl; C_1-C_4 haloalkyl; C_1-C_4 alkoxy; C_1-C_4 haloalkoxy; nitro; cyano or
- 25 C_1-C_4 alkylthio; and
- R^{28} is halogen; cyano; nitro; hydroxy; hydroxycarbonyl; C_1-C_6 alkyl; C_3-C_6 cycloalkyl; C_1-C_6 haloalkyl; C_1-C_4 alkylthio; C_1-C_4 alkylsulfinyl; C_1-C_4 alkylsulfonyl; $(C_1-C_4$
- 30 $\text{alkyl})_3\text{silyl}$; C_2-C_5 alkylcarbonyl; C_2-C_4 alkenyl; C_3-C_4 alkenyloxy; C_2-C_4 alkynyl; C_3-C_4 alkynyloxy; C_1-C_4 alkoxy; C_1-C_4 haloalkoxy; C_2-C_4 alkoxyalkyl; C_2-C_5 alkoxy carbonyl; C_2-C_4 alkoxyalkoxy; $NR^{15}R^{16}$; $C(=O)NR^{17}R^{18}$; or phenyl,

phenoxy or phenylthio each optionally substituted with R^{26} .

provided that

5 when E is, C_1 - C_6 alkylthio, C_1 - C_6 alkoxy, C_1 - C_6 haloalkoxy, phenoxy, phenylthio or phenylamino, then E may only substitute compounds of Formula I.

10 10. A fungicidal composition comprising a fungicidally effective amount of a compound of Formula I, II, III or IV



15

wherein:

- G^1 - G^2 - G^3 - taken together with the attached atoms form a 5-8 membered ring, wherein

- G^1 - is $-CR^1R^7-$; $-(CHR^1CHR^2)-$; $-(CHR^1CHR^2CHR^3)-$; or $-CHR^1CHR^2CHR^3CHR^4-$;

20

- G^2 - is $-O-$; $-S-$; $-S(O)-$; $-S(O)_2-$ or $-NR^{27}-$;

$-G^3-$ is $-CR^4R^8-$; $-(CHR^5CHR^6)-$; $-(CHR^3CHR^5CHR^6)-$ or a direct bond;

X is N or CR^{13} ;

Y is N or CR^{14} ;

5 E is H; C_1-C_6 alkyl; C_3-C_7 cycloalkyl optionally substituted with 1-2 methyl; C_1-C_6 haloalkyl; C_1-C_6 alkylthio; C_1-C_6 alkoxy; C_1-C_6 haloalkoxy; or phenyl, phenoxy, phenylthio, phenylamino, phenylmethyl, indanyl, tetrahydronaphthalenyl, 10 1-naphthalenyl, 2-naphthalenyl, thienyl, furanyl or pyridyl each optionally substituted with R^{11} , R^{12} and R^{28} ;

R^1 , R^2 , R^3 , R^4 , R^5 , R^6 , R^7 and R^8 are each independently H; C_1-C_4 alkyl; C_1-C_4 haloalkyl, 15 halogen, CO_2CH_3 , $CO_2CH_2CH_3$, cyano or phenyl optionally substituted with R^{25} ;

provided that

- (i) the maximum number of carbon atoms in $-G^1-G^2-G^3-$ with geminal disubstitution 20 is one;
- (ii) the maximum number of optionally substituted phenyl substituents on $-G^1-G^2-G^3-$ is one;
- (iii) $-G^3-$ is other than a direct bond in compounds of Formulae III and IV; and 25
- (iv) $-G^2-G^3-$ is other than $-NR^{27}-$ in compounds of Formulae I and II;

R^9 , R^{10} and R^{13} are each independently H; halogen; cyano; hydroxy; C_1-C_6 alkyl; C_1-C_4 haloalkyl; 30 C_1-C_4 alkylthio; C_1-C_4 alkylsulfinyl; C_1-C_4 alkylsulfonyl; C_3-C_6 cycloalkyl optionally substituted with 1-2 methyl groups; C_1-C_4 alkoxy; C_1-C_4 haloalkoxy; C_2-C_4 alkoxyalkyl; C_2-C_4 alkenyl; C_2-C_4 haloalkenyl; C_2-C_4 35 alkenyloxy; C_2-C_4 alkynyl; C_2-C_4 alkynyloxy;

NR²⁹R³⁰; or phenyl or phenoxy optionally substituted with R³¹; or
R⁹ and R¹³, or R¹⁰ and R¹³, or R⁹ and R¹⁴ can be taken together to form -(CH₂)₃-, -(CH₂)₄- or a fused benzene ring optionally substituted with R³¹;
R¹¹, R¹², R²¹, R²⁴, R²⁶ and R³¹ are each independently halogen; C₁-C₄ alkyl; C₁-C₄ haloalkyl; C₁-C₄ alkoxy; or C₁-C₄ haloalkoxy;
R¹⁴ is H; halogen; C₁-C₂ alkyl; or C₁-C₂ alkoxy;
R¹⁵, R¹⁶, R¹⁷, R¹⁸, R²⁹ and R³⁰ are each independently H or C₁-C₂ alkyl; or
R¹⁵ and R¹⁶, or R¹⁷ and R¹⁸, or R²⁹ and R³⁰ can be taken together along with the nitrogen atom to which they are attached to form a 4-morpholinyl, pyrrolidinyl or piperidinyl ring;
R²⁰ and R²⁷ are each independently H; C₁-C₄ alkyl; C₁-C₄ haloalkyl; C₂-C₅ alkylcarbonyl; phenyl-carbonyl optionally substituted with R²¹; C₃-C₄ alkenyl; C₃-C₄ alkynyl; phenylmethyl optionally substituted with R²¹ on the phenyl ring; C₁-C₄ alkylsulfinyl; C₁-C₄ alkylsulfonyl; phenyl-sulfinyl, phenylsulfonyl or phenoxy carbonyl each optionally substituted with R²¹; C₂-C₄ alkoxy carbonyl; C(=O)NR²²R²³; C(=S)NHR²³; P(=S)(C₁-C₄ alkoxy)₂; P(=O)(C₁-C₄ alkoxy)₂; or S(=O)₂NR²²R²³;
R²² is H or C₁-C₃ alkyl;
R²³ is C₁-C₄ alkyl; or phenyl optionally substituted with R²⁴; or
R²² and R²³ can be taken together along with the nitrogen atom to which they are attached to form a 4-morpholinyl, pyrrolidinyl, piperidinyl or imidazolyl ring;

- R^{25} is 1-2 halogen; C_1-C_4 alkyl; C_1-C_4 haloalkyl; C_1-C_4 alkoxy; C_1-C_4 haloalkoxy; nitro; cyano or C_1-C_4 alkylthio; and
- 5 R^{28} is halogen; cyano; nitro; hydroxy; hydroxy-carbonyl; C_1-C_6 alkyl; C_3-C_6 cycloalkyl; C_1-C_6 haloalkyl; C_1-C_4 alkylthio; C_1-C_4 alkyl-sulfinyl; C_1-C_4 alkylsulfonyl; $(C_1-C_4$ alkyl) $_3$ silyl; C_2-C_5 alkylcarbonyl; C_2-C_4 alkenyl; C_3-C_4 alkenyloxy; C_2-C_4 alkynyl; C_3-C_4 alkynyloxy; C_1-C_4 alkoxy; C_1-C_4 haloalkoxy; C_2-C_4 alkoxyalkyl; C_2-C_5 alkoxy carbonyl; C_2-C_4 alkoxyalkoxy; $NR^{15}R^{16}$; $C(=O)NR^{17}R^{18}$; or phenyl, phenoxy or phenylthio each optionally substituted with R^{26} ;
- 10
- 15 provided that
- when E is, C_1-C_6 alkylthio, C_1-C_6 alkoxy, C_1-C_6 haloalkoxy, phenoxy, phenylthio or phenylamino, then E may only substitute compounds of Formula I;
- 20 and agriculturally suitable salts and metal complexes thereof and at least one of (a) a surfactant, (b) an organic solvent and (c) at least one solid or liquid diluent.

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) ⁶		
According to International Patent Classification (IPC) or to both National Classification and IPC Int.Cl. 5 C07D413/04; C07D417/04; A01N43/88		
II. FIELDS SEARCHED		
Minimum Documentation Searched ⁷		
Classification System	Classification Symbols	
Int.Cl. 5	C07D	
Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched ⁸		
III. DOCUMENTS CONSIDERED TO BE RELEVANT⁹		
Category ¹⁰	Citation of Document, ¹¹ with indication, where appropriate, of the relevant passages ¹²	Relevant to Claim No. ¹³
P,A	WO,A,9 211 249 (DU PONT DE NEMOURS) 9 July 1992 * claims *	1-10
A	----- CHEMICAL ABSTRACTS, vol. 83, 1975, Columbus, Ohio, US; abstract no. 10171, POTEKHIN, A. A., NIKOLAEVA, N. M. '5,6-Dihydro-4H-1,3,4-oxadiazines.' see abstract & SU,A,461 929 28 February 1975 cited in the application ----- -/-	1-10
<p>¹⁰ Special categories of cited documents:</p> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p> <p>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step</p> <p>"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.</p> <p>"Z" document member of the same patent family</p>		
IV. CERTIFICATION		
Date of the Actual Completion of the International Search 13 JULY 1993		Date of Mailing of this International Search Report 26. 07. 93
International Searching Authority EUROPEAN PATENT OFFICE		Signature of Authorized Officer Bernd Kissler

III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)		
Category *	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No.
A	CHEMICAL ABSTRACTS, vol. 90, 1979, Columbus, Ohio, US; abstract no. 152131, DOVLATYAN V V; GEVORKYAN R A 'Synthesis of pesticides. Reactions of halonitriles with esters of s-triazinyldithiocarbazic acid.' see abstract & ARM. KHIM. ZH. (AYKZAN,05159628); 78; VOL.31 (11); PP.851-6 ---	1-10
A	CHEMICAL ABSTRACTS, vol. 87, 1977, Columbus, Ohio, US; abstract no. 102359, DOVLATYAN V V; GEVORKYAN R A 'Synthesis of pesticides. II. Study of the reaction of potassium hydrazino-s-triazine with chloroacetonitrile and .alpha.,.beta.-dichloropropionitrile and its urotropine salt' see abstract & ARM. KHIM. ZH. (AYKZAN,05159628); 77; VOL.30 (10); PP.851-4 ---	1-10
A	CHEMICAL ABSTRACTS, vol. 89, 1978, Columbus, Ohio, US; abstract no. 43349, DOVLATYAN V V; GEVORKYAN R A 'Oxadiazinyl-s-triazine derivatives' see abstract & SU,A,556 143 (ARMENIAN AGRICULTURAL INSTITUTE; USSR) 30 April 1977 -----	1-10

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 93/03583

Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest.
- ☐ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/

The definition of the following substituent(s) is too general and/or encompasses too broad a range of totally different chemical groups, only partly supported by examples given in the descriptive part of the application:

X, Y, G1, G2, G3, E

The number of theoretically conceivable compounds resulting from the combination of all claimed substituents of above list precludes a comprehensive search. Guided by the spirit of the application and the inventive concept as disclosed in the descriptive part of the present application the search has been limited to the following case(s):

1. 4-(2-Pyridyl or 2-Pyrimidyl or 2-Triazinyl)-1,3,4-Oxa/thiadiazines
2. 4-(2-Pyridyl or 2-Pyrimidyl or 2-Triazinyl)-1,3,4-Oxa/thiadiazepines
3. 4-(2-Pyridyl or 2-Pyrimidyl or 2-Triazinyl)-1,3,4-Oxa/thiadiazocines

US 9303583
SA 73324

13/07/93

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO-A-9211249	09-07-92	AU-A- 9127091 CN-A- 1062726	22-07-92 15-07-92

WFO FORM 2071

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

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